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CLEANING PHILADELPHIA'S SLOW-SAND FILTERS MECHANICALLY

BY GEORGE G. SCHAUT[1]

The first unit of the slow-sand filters for Philadelphia was completed in 1902 and was put into operation under the direction of John W. Hill, but it was not until 1912 that the filtration program was completed and the entire city placed on a filtered-water basis.

During the early days of slow-sand filters, the plants were constructed with large open courts which provided a place for storing sand after it was washed. The dirty sand was wheeled in barrows to the sand-washers situated on the court; it was washed there and then spread out in bins and exposed to the action of the air and the sunlight because this was supposed to be beneficial to the sand, but it was a slow and costly procedure. After this method had been practised for about a year, it was found that sand could be removed from the filter to the sand-washer on the court by means of portable ejectors and hose. Not long after this, the portable separators developed by E. M. Nichols for the Philadelphia Sand Filters were made a part of the ejector outfit. Thus, a complete sand-washing unit was available which could be moved easily from place to place. However, since the inventor was not satisfied with this method, he developed a machine recently whereby the sand can be scraped and

[1] Superintendent in charge of Belmont Filters, Bureau of Water, City of Philadelphia.

fed to an ejector by means of a screw conveyor, thus eliminating much hand scraping and shoveling. The machine is illustrated in figure 1.

THE NICHOLS SCRAPER

The machine developed by Mr. Nichols consists of a structural steel chassis mounted upon caterpillar treads in a manner similar to that used in the ordinary tractor, but the treads are made of wood instead of iron; it is driven by a 2-h.p. electric-motor. The speed of the motor is reduced considerably by means of a gear-train and worm-drive, together with a friction wheel and plate drive, providing the machine with a forward travel of from 2 to 24 inches per minute. Across the front of the machine is the screw conveyor which scrapes the sand and carries it to a hopper located at the center, just back of the screw. In the hopper is an ejector. Water, at a pressure of 90 pounds per square inch, enters a nozzle at the bottom of the ejector. A spray pipe equipped with small nozzles is located around the bottom of the ejector on the inside, by means of which jets of water pass across the ejector bottom, and this process mixes the dry sand with sufficient water to allow it to be picked up by the ejector. After the mixture of sand and water passes through the throat of the ejector, it is passed to the separator which is carried upon the frame of the machine. Baffle plates located in this separator cause the sand to be separated from the water and, after the sand collects on the conical bottom, it is drawn off through a 2-inch hose and replaced in the depression left at the rear of the machine. The dirty water passes out at the top of the separator through a 3-inch hose to the wash-water pipes and is then passed to the catch-box at the filter entrance.

The operation of placing the machine in the filter consists of pushing it into the sand-run entrance on a truck, suspending it from the roof by means of a chain-hoist, removing the truck and lowering the machine until it rests on the surface of the sand. The total weight of the machine when suspended from the roof of the filter is about 3000 pounds. After the separator has been placed on the machine and filled with water and sand under operating conditions, the total weight is approximately 6000 pounds. The pressure on the sand that is caused by the machine is insignificant because that portion of the sand at the rear of the machine is spaded before the washed sand is relaid. An operator and helper comprise the wash-

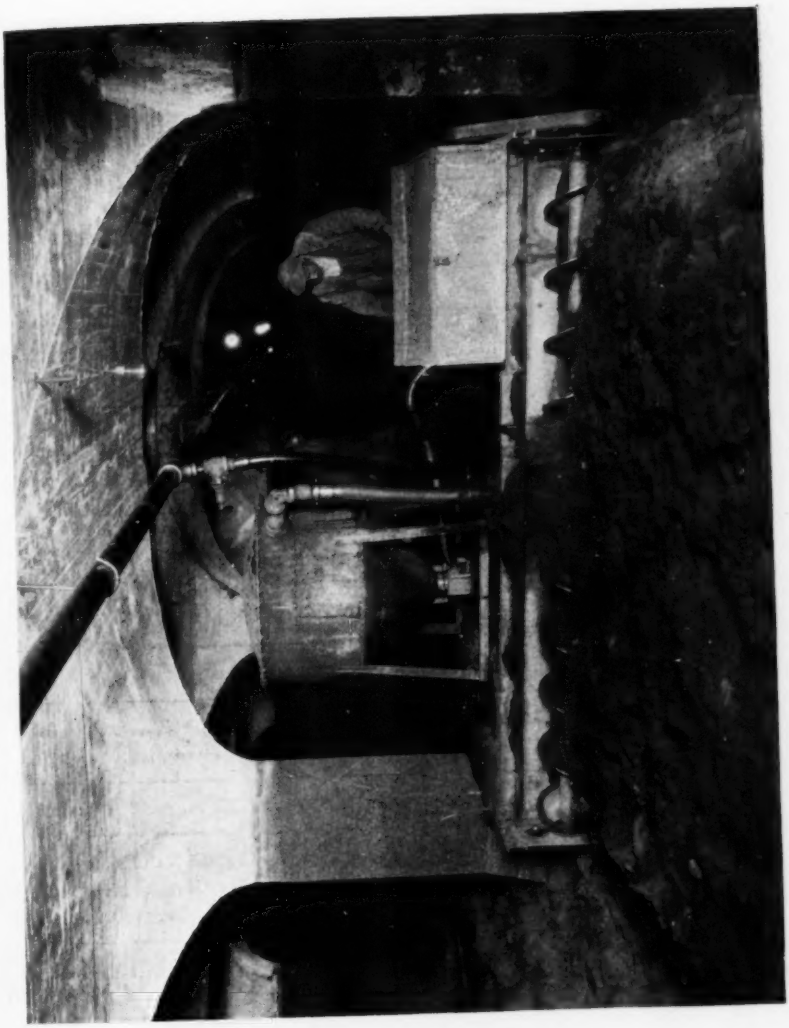


FIG. 1. NICHOLS SCRAPER

ing crew. The helper's chief duty is to relay the washed sand as it is drawn from the separator.

The sand can be scraped to any desired depth, but it is necessary to keep the sides free from sand by scraping a trench on each side and piling the sand ahead of the machine. A lever equipped

TABLE 1

Cost sheet for cleaning a 0.735-acre filter to a depth of 14.3 inches with the Nichols Scraper

	TIME	RATE	TOTAL	GRAND TOTAL
	hours	*dollars*	*dollars*	*dollars*
Moving the machine in and out:				
Foreman	16	0.52	8.32	
Operator	26	0.56	14.56	
Laborers	66	0.50	33.00	55.88
Scraping:				
Foreman	8	0.52	4.16	
Laborers	14	0.50	7.00	11.16
Washing:				
Foreman	60	0.52	31.20	
Operator	172	0.56	96.32	
Laborers	365	0.50	182.50	310.02
Total cost for labor				377.06
Quantity of water used, 1,695,000 gallon at $30 per million gallon				50.86
Electric power consumed, 212 kw-hr. at $0.01 per kilowatt-hour				2.12
Total cost of cleaning				430.04
Total quantity of sand washed, cubic yards				1,413
Cost per cubic yard, cents				30
Rate of washing per hour, cubic yards				10

with a ratchet is located on each side of the machine, by means of which the chassis can be raised or lowered to vary the depth of the cleaning according to the contour of the sand. Each tread is independent of the other so that the machine can be made to turn on its own radius.

To clean the bed, it is only necessary to work the machine up one

FIG. 2. CATCH BOX, FILTER ENTRANCE

bay and down the next bay until all the sand has been washed. The sand between the piers and out of the path of the machine must be shoveled onto the machine's path for cleaning. The cost sheet for cleaning a 0.735-acre filter with the Nichols scraper is presented in table 1.

The turbidity of the sand before cleaning, in the operation referred to in table 1, was as follows:

	Turbidity *p.p.m.*
Upper 5 inches	1,600
5 to 8 inches below the surface	350
8 to 14 inches below the surface	350
Below 14 inches	300

The turbidity of the sand after washing to a depth of 14.3 inches as in table 1 was 350 p.p.m., and the discharge water showed a turbidity of 4500 p.p.m.

The average turbidity remaining in the sand after washing is about 150 p.p.m. If, however, the sand is unusually dirty before cleaning, the residual turbidity after washing may run as high as 350 p.p.m.

A quantity of sand is carried away with the discharged water and this is caught in a box at the sand-run entrance (see fig. 2). With a discharge rate of 125 gallons per minute, the quantity of sand when cleaned and dry is about $\frac{2}{3}$ pound for every 52 gallons of water discharged. For the cleaning to a depth of 14.3 inches this amounted to $5\frac{1}{2}$ cubic yards. For the average depth of cleaning, it is roughly 0.5 per cent of the total sand washed.[2] The sand is fine and very uniform as is shown by the following analysis:

MESH				CHARACTERISTICS		
100	80	60	50	10 per cent	60 per cent	Uniformity coefficient
2.0	10.3	45.5	88.4	0.18 mm.	0.28 mm.	1.6

[2] The discharge rate and the sand carried away with the discharge water were determined by collecting a barrel, the volume of which is known, of discharge water and recording the time to fill. Then the sand was allowed to settle out and the dirty water decanted. After washing this sand free of suspended matter it was dried at 100°C. and the volume measured and also the weight recorded.

If it is desired to salvage this sand, it is only necessary to wash it by the ejector-separator method and to spread it over the sand in the filter; the sand, after washing by this method, has practically the same physical character as to size as it had before. To use any of the methods already mentioned, it is necessary to have the water drained from the filter.

BLAISDELL TYPE OF FILTER-WASHER

H. W. Blaisdell,[3] a filtration engineer, conceived the idea in about the year 1900 of washing sand under water by means of a machine, using the principles of agitation and of the upward flow of water. The machine, resembling the ordinary type of crane, was built to run on tracks attached to the side walls of the filter, and the first installation was made at Yuma, Ariz. It consisted of a steel compartment or chamber which could be raised and lowered and also moved across the filter from side to side on tracks located on the crane. Inside of the chamber was a large hollow wheel having hollow teeth located on its circumference and pointing downward; the teeth had small holes in them and, when the chamber was lowered so as to just graze the surface of the sand, the teeth were then beneath the sand surface. By pumping water through the small holes in the teeth, jets of water were thrown in a radial direction toward the hub of the wheel while it rotated slowly as the machine moved along the track. These jets of water washed the sand within the circumference of the wheel and, as the dirty water came to the surface within the chamber, it was only necessary to pump this water out and to discharge it into a trough on the side wall of the filter which conveyed the dirty water to the sewer. To clean the bed, it was customary to have the machine work back and forth until the full width of the filter was washed.

BLAISDELL BELT-TREAD FILTER-WASHER[4]

The use of the track machine was limited to filters of special design and it could not be used in the usual slow-sand filters, especially in those of the groined-arch construction. In recent years the inventor conceived improvements by which a sand washer is made to travel bodily on the sand bed and tracks are not required. This took

[3] See Rapid Fine-Sand Filtration, THIS JOURNAL, Vol. 14, No. 6, p. 581.

[4] The first installation consists of six machines.

the form of a tractor with long wide endless-belts for treads and, in 1922, the first machine of its kind was tried in the Belmont Filters,[5] for the Philadelphia Water Bureau. Although not entirely successful during the first trial, its merit was recognized as a practical method of cleaning slow-sand filters that were already built. After further experimenting with the machine, the type shown in figure 3 was developed.

The machine consists of a structural steel chassis upon which are mounted a gasoline engine, the driving mechanism and a washing head. A belt-tread, driven by sprockets and chains, is located on each side of the chassis. The washing-head is made up of the washing chamber, which contains six stirrer-wheels equipped with teeth, the floats or air-chambers constituting what are known as the front and the rear shoes. The six stirrer-wheels are each 1 foot in diameter and are attached to the lower ends of the shafts shown above the washing-chambers. Three wheels revolve clockwise, at 65 r.p.m., while the other three wheels revolve in a counter-clockwise direction. Each wheel has eight teeth and these can be of any desirable length.

At the upper end of each stirrer-shaft is a gear case containing the driving-gears, which run in oil. One drive-shaft connected to the engine transmits the power to the stirrer-wheels. The washing-head, as a unit, is pivoted to the two radius-arms that raise and lower it, and, by means of this pivot connection, the unit follows the contour of the filter surface. Although the washing-head weighs approximately 1000 pounds, it adds practically no weight to the tractor when submerged. The weight of the filter-washer when operating is approximately 8000 pounds. Centrifugal pumps connected by a single drive-shaft driven by a silent-chain connected to the transmission supply the water for the teeth and lift the dirty water from the washing-chamber, discharging it into a 3-inch hose which conveys it to the wash-water pipes leading to the settling-box at the filter entrance. All water used for washing the sand is pumped directly from the surface water in the filter.

In the head of the washing-chamber is a $\frac{1}{4}$-inch mesh screen to protect the pumps from foreign material. The machine is designed to wash somewhat more than one-half of the width between the piers, thus making it necessary to make two trips in each bay to

[5] All the experimental work, together with the final acceptance test, was performed at Belmont Filters from the year 1922 to the year 1925.

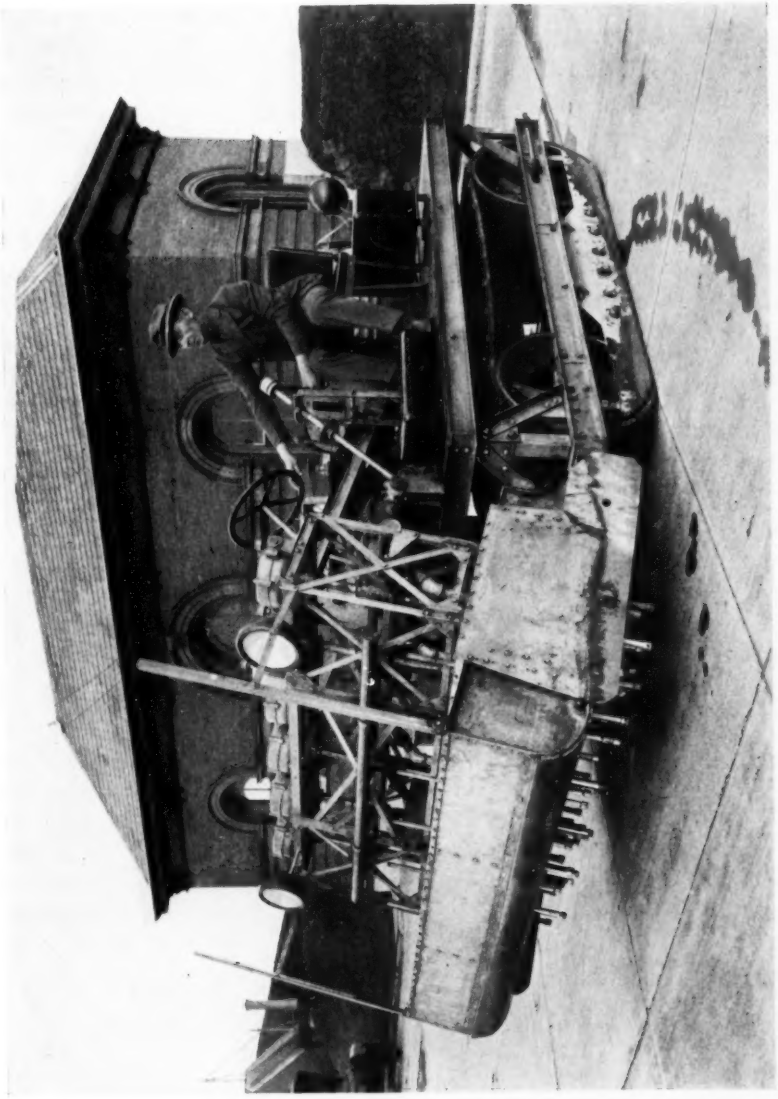


FIG. 3. BLAISDELL BELT-TREAD FILTER WASHER

accomplish a single cleaning. As shown in figure 3, the washing-chamber is 80 inches wide and 24 inches from the heel of the front shoe to the toe of the rear shoe. The total quantity of dirty water discharged into the sewer is approximately 175 gallons per minute, 40 gallons of which represents water supplied by the force pump to the teeth. The proper size of the holes in the teeth is determined by experience, to meet specified conditions. The most desirable size found by experience at the Belmont Filters has been either two $\frac{5}{16}$-inch or three $\frac{3}{16}$-inch holes.

The washing-head is raised or lowered as a unit by means of a lever and ratchet located near the operator's left hand. His right hand rests on the steering-wheel, which operates the differential mechanism that allows either belt-tread or both belt-treads to move. A lever operates the clutch between the engine and the transmission. Another lever controls a clutch that allows the pumps and the stirrer-wheels to be started or stopped. The transmission is similar to that of an automobile, except that the gear-ratios are somewhat different. The transmission has three forward speeds; namely, 5, 10, and 15 feet per minute. One reverse speed of 10 feet per minute is provided.

The belt-tread consists of two endless rubber-covered-fabric belts to which metal cleats are attached. The belts are 27 inches wide and run over two driven wheels at each corner of the tractor; each wheel is 24 inches in diameter by 13 inches wide and is separated from the other wheel by a 1-inch slot. The center-to-center distance between the two wheels on each side is approximately 60 inches, and varies with the tension of the belt. The pressure on the sand when washing, due to the weight of the machine, is about $2\frac{1}{2}$ pounds per square inch, or less than that caused by the average person when walking on the sand of the filter. Slippage between the wheels and the belts cannot occur owing to an ingenious drive. Each belt-tread is independent of the other so that the washer can be made to turn on its own radius.

OPERATION

Normally, the washer operates with the washing unit ahead. To wash a filter, it is only necessary to drain the water to within 2 feet of the surface of the sand and to shut down the filter. By means of a ramp at the sand-run entrance, the washer enters the filter and operates entirely under its own power. When the tractor

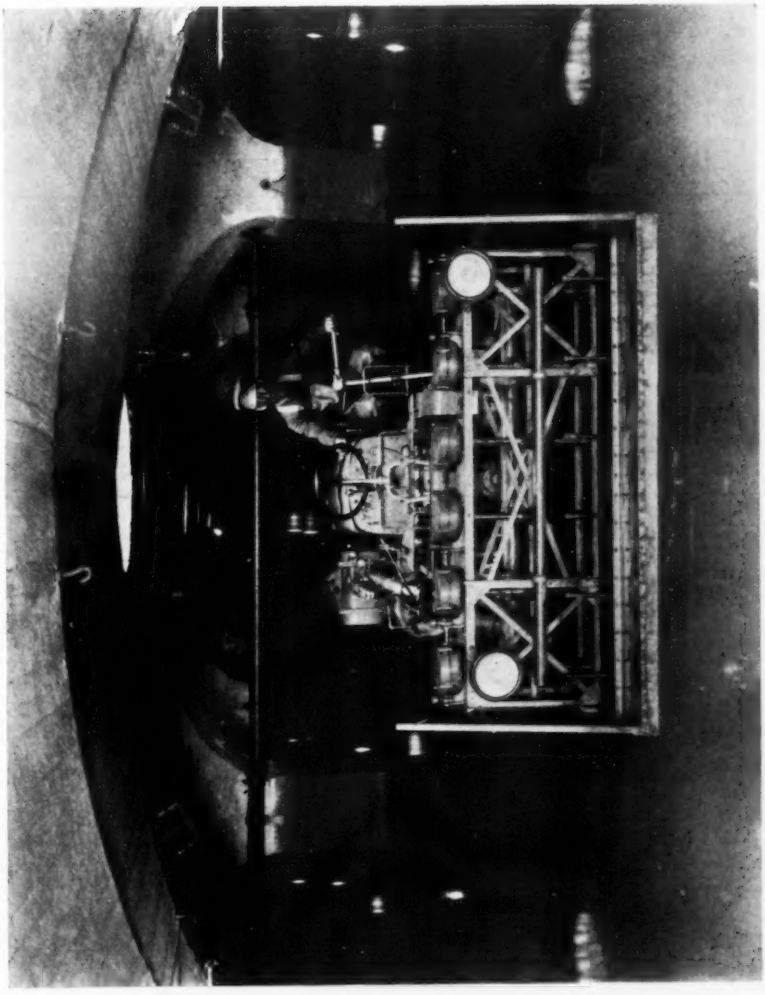


FIG. 4. BLAISDELL BELT-TREAD WASHER IN OPERATION

is on the sand of the filter, the discharge hose is connected, the pumps are primed, the stirrer-wheels are started and, at the same time, the washing-unit is lowered until the shoes just graze the surface of the sand. The machine is then ready to travel over the filter and to remove the clogging matter and any entrained air from the sand

TABLE 2

Cost sheet for washing a 0.735-acre filter twice over, using a Blaisdell Belt-Tread Filter-Washer equipped with 6-inch and 8-inch teeth. Speed 10 feet per minute

	TIME	RATE	TOTAL	GRAND TOTAL
	hours	*dollars*	*dollars*	*dollars*
Moving the machine in and out:				
Operator	1	0.625	0.625	
Helper	1	0.500	0.500	1.125
Washing:				
Operator	25	0.625	15.625	
Helper	25	0.500	12.500	28.125
Total cost for labor				29.250
Quantity of water, gasoline and oil used:				
Water, 250,000 gallons at $15 per million gallons				3.750
Gasoline, 23 gallons at $0.17 per gallon				3.910
Oil, ½ gallon at $0.37 per gallon				0.185
Total cost of washing				37.095
Total quantity of sand washed,* cubic yards				590
Cost per cubic yard, cents				6
Rate of washing per hour,† cubic yards				29½

* The total amount of sand washed is obtained by multiplying the depth of cleaning by the area of the filter; it is not a function of the number of trips. The depth of cleaning is 2-inches less than the longest tooth used.

† The rate of washing per hour is the number of cubic yards divided by the net time of washing, which, in this case, was 20 hours.

(see fig. 4). The speed of the engine is controlled by a governor that causes the machine to maintain a definite speed of travel, depending upon the gear-ratio used. The washing-crew consists of a driver and a helper, the duty of the helper being to attend to the hose as it floats on the water and to make all connections. The men wear

water-tight rubber suits commonly called waders. A cost sheet for washing a 0.735-acre filter, using a Blaisdell belt-tread filter-washer is presented in table 2.

As a means of affording comparisons of the costs per cubic yard of washing sand, the following data are stated:

Method	*Dollars per cubic yard*
Wheeled out in barrows	4.44
Ejected out	1.58
With a Nichols Separator	0.50
With a Nichols Scraper	0.30
With a Blaisdell Belt-Tread Filter-Washer	0.06

The turbidity of the sand before cleaning[6] was as follows:

	Turbidity *p.p.m.*
Upper 3 inches	2,700
3 to 5 inches below the surface	500
5 to 15 inches below the surface	400
Below 15 inches	300

The turbidity of the upper 8 inches of sand after each of four washings was:

	Turbidity *p.p.m.*
First washing	950
Second washing	750
Third washing	700
Fourth washing	400

The turbidity of the discharged water after each of four washings was:

	Rate of travel *Feet per minute*	Turbidity *p.p.m.*
First washing	4¾	4,500
Second washing	8	4,000
Third washing	8	3,400
Fourth washing	8	1,800

The foregoing data are for a very dirty filter. Under normal conditions, two trips over the bed are sufficient. The sieve analysis for various washings is stated in table 3.

SAND REMOVAL AND CONDITIONS AFTER WASHING

The quantity of sand carried away by the discharged water is very small; it is caught in a settling box at the sand-run entrance

[6] The turbidity of the sand is determined by taking 100 grams of sand and shaking it 100 times while immersed in 1 liter of water, and then reading the turbidity of the water.

(see fig. 2). With a discharge rate of 175 gallons per minute, the quantity of sand when clean and dry is about 1 pound for every 52 gallons of water discharged, or, for the usual cleaning, consisting of one length-wise wash and one cross-wise wash, it is about 1 cubic yard. This sand has practically the same physical characteristics as that used by Blaisdell in his rapid fine sand filters. It is possible to prevent the loss of this fine sand even with higher discharge rates, for very recently the discharge rate has been increased to 220 gallons per minute with practically no sand in the discharge water.

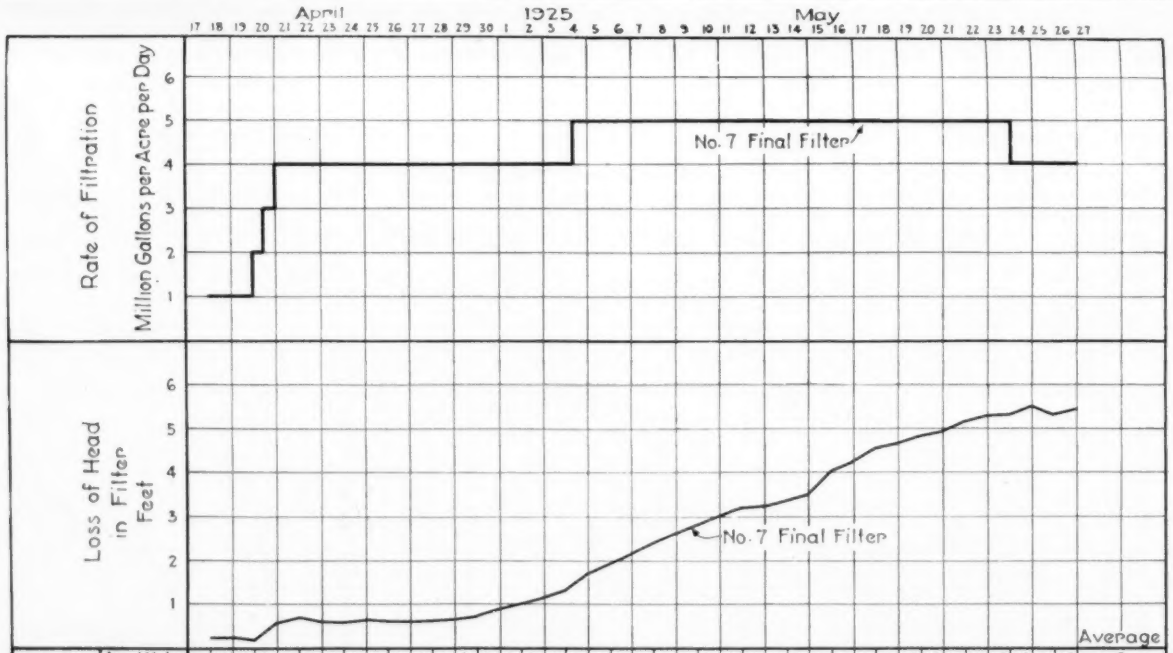
If, after washing the filter, the water in it is drained so that its level is below that of the sand surface, a very thin skim of mud is

TABLE 3

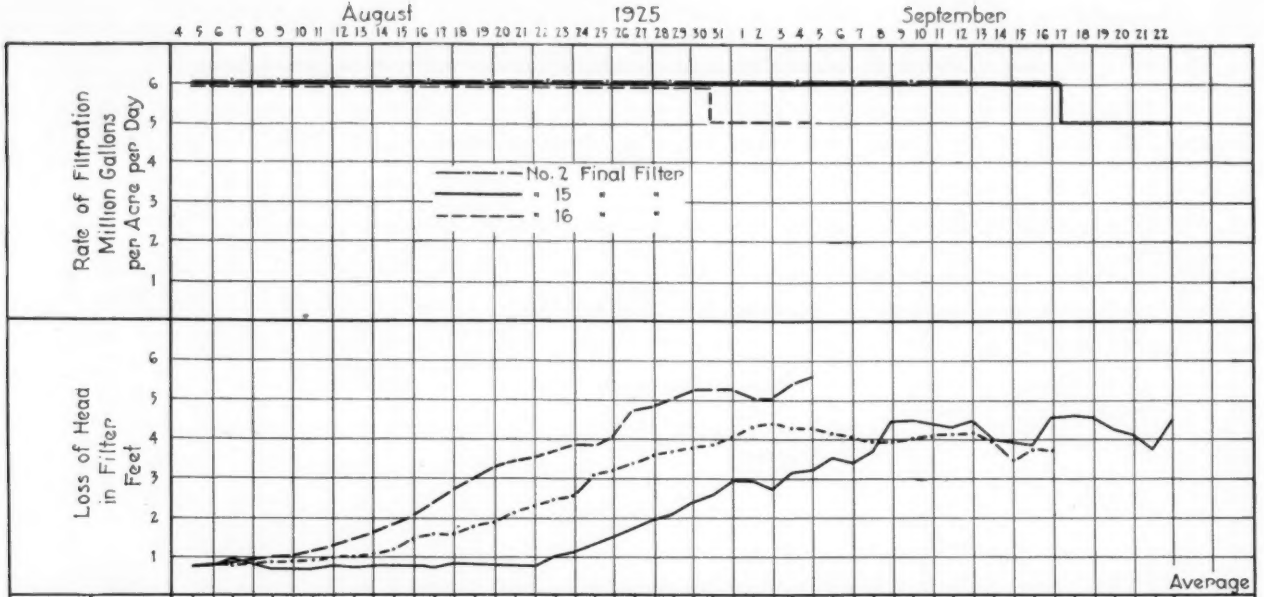
Sieve analysis for various washings

	MESH							10 PER CENT	60 PER CENT	UNIFORMITY COEFFICIENT
	100	80	60	50	40	30	20			
								mm.	*mm.*	
Original condition.....		1.0	5.1	11.3	16.4	27.0	61.6	0.33	0.85	2.58
First washing.....			3.2	10.0	14.0	26.5	62.0	0.35	0.85	2.43
Second washing.....			4.3	10.0	15.5	28.0	64.0	0.35	0.81	2.32
Third washing.....			3.4	10.0	14.8	27.1	62.4	0.35	0.83	2.38
Fourth washing.....			4.3	11.5	17.5	29.6	64.2	0.33	0.80	2.42
Sand carried away with the discharged water..		7.4	29.1	67.4				0.20	0.33	1.65

formed over the entire surface of the bed. This might be called an artificial "schmutzdecke." Beneath this, the sand is uniformly clean and bright and has the appearance of being uniformly relaid; with the exception that, upon close examination, it is noticed that a thin layer of very fine sand underlies and is just beneath the skim of mud. This fine sand is the result of the classification of the sand grains by the upward washing. The layer of fine sand, together with the so-called "schmutzdecke," gives the filter a high initial efficiency. Too much fine sand left on the surface of the filter reduces the total yield so that it is highly desirable to allow most of this fine sand to be carried off with the discharge water.


April 1925 May
17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Rate of Filtration
Million Gallons per Acre per Day
1 2 3 4 5 6
No. 7 Final Filter
Loss of Head in Filter Feet
1 2 3 4 5 6
No. 7 Final Filter

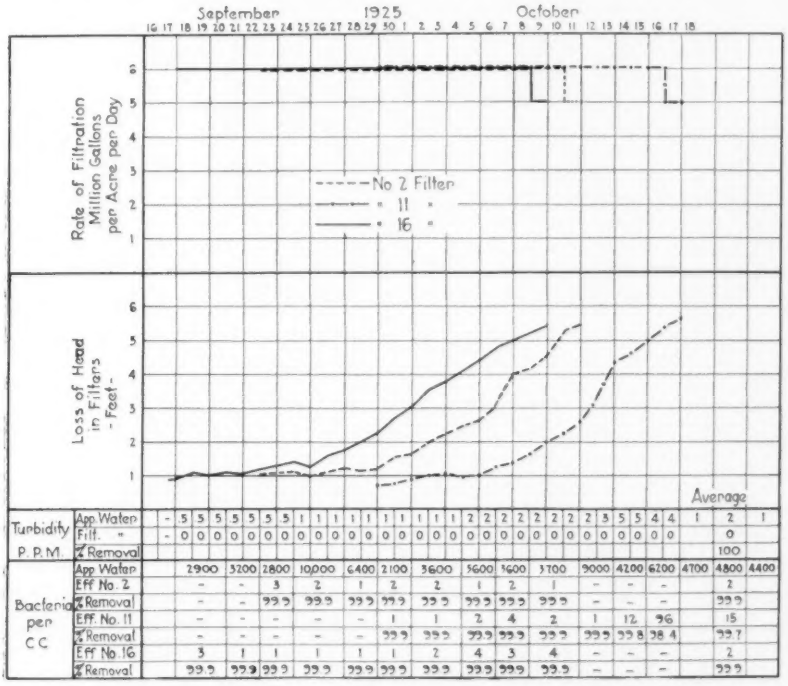
| | | |


August 1925 September
Rate of Filtration Million Gallons per Acre per Day
No. 2 Final Filter
" 15 " "
" 16 " "
Loss of Head in Filter Feet

| | | |

RATE, LOSS OF HEAD, TURBIDITY AND BACTERIA REMOVAL

The rate, loss of head, turbidity and bacteria removal from filters cleaned by the Nichols and by the Blaisdell machines are shown in



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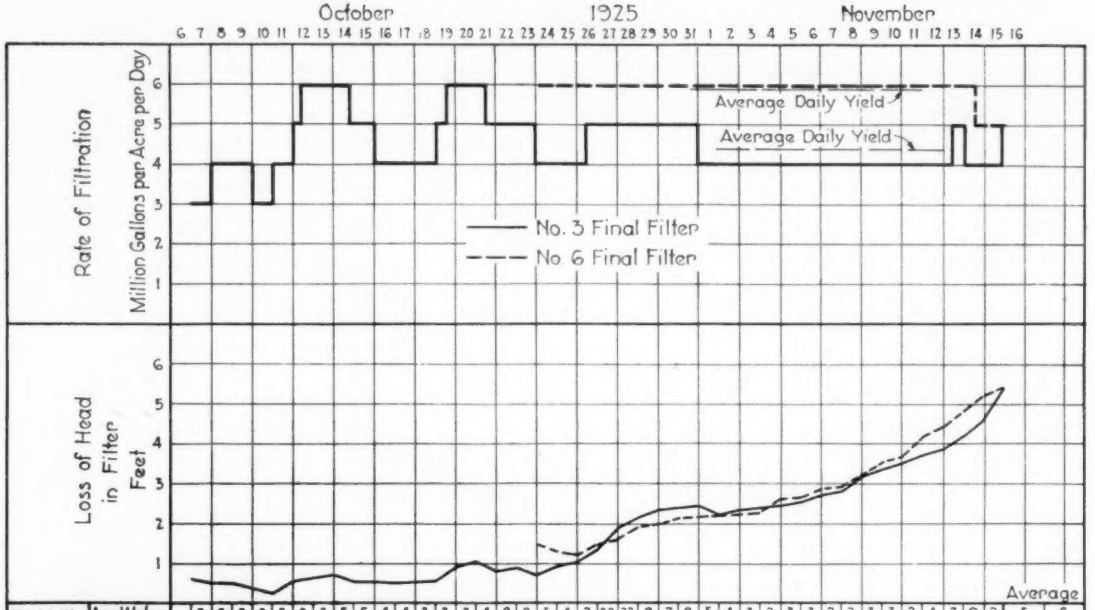
October
1925
November
Rate of Filtration
Million Gallons per Acre per Day
Average Daily Yield
Average Daily Yield
No. 3 Final Filter
No 6 Final Filter
Loss of Head in Filter Feet
Average

| | | |

the filters at high rates following a cleaning with a Blaisdell machine. In the case of all filters cleaned by the Blaisdell washer, they were started immediately after sand samples were collected; thus, no preliminary treatment like raking or cultivating was done. If it is not desirable to see the condition of the filter after cleaning, the

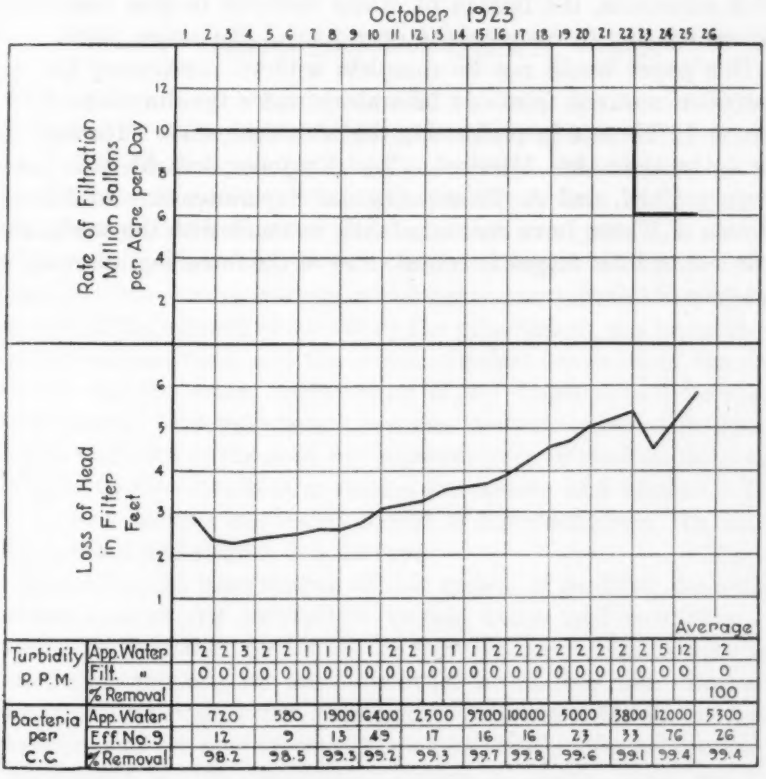

FIG. 9. BELMONT FILTERS

No. 9. Final filter cultivated by Cleveland Tractor to depth of 4 to 5 inches. Total yield per acre = 228.0 million gallons. Average daily yield per acre = 9.5 million gallons. First cultivation after Blaisdell Wash.

supply water can be turned on while the machine is moving from the filter thus allowing immediate operation. This gives a better idea of what the machine is capable of doing. It is, however, my experience that cultivating the surface of the sand before putting the filter into operation will greatly lengthen the run, thus giving a greater quantity of water between cleanings.

CONCLUSION

The Blaisdell washers in their present design have given the results anticipated by the engineers of the Philadelphia Water Bureau; but, until the runs of filters so washed have extended over at least a period of one year of service and the seasonal changes have given their reflections, the Bureau of Water hesitates to give conclusive figures relating to costs on the operation of the entire plant.

This paper would not be complete without mentioning the cooperation received from our laboratory under the direction of Dr. George E. Thomas in performing the analytical work. Throughout the entire time Alex. Murdoch, Chief Engineer, Seth M. Van Loan, Deputy Chief, and A. Tolson, General Superintendent of Filters, Bureau of Water, have been constantly in touch with the work, and it is due to their suggestions that most of the foregoing information has been obtained.

DISTRIBUTION FEEDER SURVEY AS A BASIS FOR IMPROVEMENT STUDIES[1]

By V. Bernard Siems[2] and Edgar K. Wilson[3]

Maintenance and reconstruction of the water distribution system in Baltimore are guided chiefly by the results of the routine pitometer survey conducted by the Conservation Sub-division of the Distribution Division. This pitometer survey is a nucleus about which are grouped other routine companion surveys, which are also conducted continuously as an essential function of maintenance. Results of the various surveys, which are concerned with the interior as well as the exterior condition of the pipe system, are brought together and analyzed, and the actual physical condition of the pipe system and the actual performance of the distribution system are ascertained. This information becomes the basis of new distribution design and with it the need for improvements or modifications and changes in the distributing system are known and applied. The companion surveys mentioned consist of the electrolysis, the valve, the pressure and the fire flow surveys.

Soon after the inauguration of this system of studying the actual performance of the distribution system under field conditions, it became evident that certain of the principal feeder mains were not functioning properly for the purpose for which they were designed. It also became evident that, although the analyses of the water waste, pressure, and fire flow surveys, when correlated, indicated inefficient performance by the distribution system in certain cases, yet the specific cause could only be guessed; and, indeed, the data that could thus be collected to show the percentage of efficiency of the several mains were judged unreliable. It seemed advisable, therefore, to our engineers that a separate investigation of flow conditions be made at points indicated by their study of the regular maintenance surveys. Direct measurements with the pitometer and loss of head tests by

[1] Presented before the Buffalo Convention, June 10, 1926.

[2] Water Engineer, Baltimore, Md.

[3] Chief Engineer, The Pitometer Company, New York, N. Y.

suitable pressure gauges, which had to be developed to meet the special needs of precise measurements, were deemed the best instruments adapted to this study.

Although we believe the investigation which was planned should be undertaken without delay, we were reluctant to withdraw our regular operators from their regular survey work; nor was it possible for us to enlarge our organization for this purpose.

For work so highly technical and precise, experienced operators would be required. The Pitometer Company was called upon, therefore, for the necessary instruments and engineers to coöperate with our Department in its investigation. Our studies covered a period of approximately four months, and included the investigation of mains ranging in size from 16- to 60-inch in diameter for which approximately 150 gauging points were located. We are certain from the results obtained that the cost of this work has been justified.

Feeder mains designed to perform important functions in the distribution system were found to be doing no appreciable part of the work contemplated for them, and consequently other mains were found with velocities higher than desirable. Had rule of thumb methods been adopted, instead of a more scientific basis for improvement design, these conditions might have led to the uneconomic addition of other mains to the distribution system for the purpose of carrying the necessary water not delivered by those mains working below capacity, or to relieve the load on those mains in which very high velocities were found to exist.

Since the data obtained also clearly indicated the interior condition of the mains, the information was of great value in determining the advisability of cleaning some of the mains for the purpose of saving, at least for a period of years, additional construction.

About the same time that the distribution feeder survey was undertaken the Department inaugurated a water main cleaning program to correct conditions of decreased feeder capacity. From our available sources of information, this program included only feeder mains and important distributing mains, for it is difficult to determine the necessity for cleaning short secondary distributing mains, unless sub-division is resorted to and many pitometer measurements taken. On the other hand, it is not difficult to determine the necessity for cleaning feeder mains or long unsupported distributing mains, if there are any in the system, and also of determining, after cleaning, the benefits derived. Thus, by cleaning we were able to restore the

TABLE 1

First service zone of distribution

LOCATION	DIAMETER	LENGTH	VELOCITY	LOSS PER 1000 FEET	COEFFICIENT	REMARKS
	inches	*feet*	*feet/second*	*feet*		
Washington Street, E...	40	6,770	2.40	1.36	71	
Washington Street, W...	40	6,770	2.96	1.441	87	
Washington Street, E...	40	4,625	1.83	0.843	71	
Washington Street, W...	40	6,360	2.04	0.61	93	
Madison Street.....	30	1,255	1.15	0.32	90	
Lombard Street.....	40	4,830	1.76	0.50	91	
Hopkins Place.....	40	2,940	1.79	0.442	118	Numerous side connections. Measurements at ends
Hanover Street.....	30	1,915	1.79	0.63	98	
22nd and Ensor Streets.	48	4,030	3.39	0.892	114	
Ensor Street.....	36	850	3.08	3.30	61	
Ensor Street.....	36	850	2.71	2.12	68	
John Street.....	30	2,960	1.6	0.642	87	
St. Paul Street.....	30	1,130	0.52	0.177	56	Low velocity combined with short length make test unreliable. However, results check
		1,130	1.16	0.71	59	
Taylor Street.....	60	7,000	3.62	0.686	120	
Montreal Street.....	30	1,775	2.27	0.76	110	
North Avenue.....	36	1,100	2.34	0.817	99	
Washington Street.....	48	2,115	3.12	0.945	102	
North Avenue.....	48	9,690	0.58	0.021	148	
			0.785	0.113	81	
Lennox Street.....	40	4,240	2.87	1.41	85	
McMechen Street.....	40	1,100	1.65	0.54	98	
Hoffman Street.....	40	2,240	3.34	1.48	98	
North Avenue, N.S.....	36	1,250	2.19	0.432	130	
North Avenue, N.S.....	36	1,275	2.0	0.502	110	
Henrietta Street.....	30	2,870	1.48	0.383	106	
Greene Street.....	30	2,465	1.59	0.365	116	
Lombard Street.....	30	1,550	0.75	1.096	31	
Hollins Street.....	30	635	0.86	1.418	30	
Hoffman Street.....	30	1,040	1.69	0.481	107	
Biddle Street.....	30	1,900	1.51	0.421	102	
Cathedral Street.....	30	2,005	0.81	0.34	62	

TABLE 1—*Concluded*

LOCATION	DIAMETER	LENGTH	VELOCITY	LOSS PER 1000 FEET	COEFFICIENT	REMARKS
	inches	*feet*	*feet/second*	*feet*		
Eager Street	30	1,660	1.10	1.14	44	
Madison Street	40	5,000	2.85	1.18	92	
Greene Street	30	800	2.10	0.63	115	
North Avenue, S.S	36	700	2.76	2.0	91	
Eager Street	30	1,200	2.04	0.583	116	
Eager Street	30	3,055	2.32	1.505	79	
Russell Street	30	1,790	0.30	0.06	61	
Mt. Royal Avenue	30	1,100	0.66	0.09	102	
Mt. Royal Avenue	48	710	1.81	0.85	63	Short length of pipe increased possibilities for errors sufficient to destroy accuracy of test

capacity of several important mains to approximately the capacity of those mains when new; in other words, we found pipe cleaning to be a very practical method of raising the pipe coefficient of mains known to be functioning poorly, because of tuberculation.

Naturally, these mains were the ones whose age of service were greatest. Conditions in Baltimore also make this true, for greatest tuberculation was disclosed in the pipe lines which were laid and in service for a period of years, prior to the construction of our filtration plant. The water which we now serve is not considered corrosive, being filtered and treated at the Montebello Filtration Plant, but we are now attacking the problem of reducing pipe corrosion to the minimum by more refined methods of raw water treatment.

As the practical result of our pipe cleaning program, which may properly be considered as related to our distribution feeder survey, we have concluded that low pipe coefficients due to tuberculation may be expected in the very oldest mains in service, that cleaning is justified, and that cleaning may be the most economically performed in the case of larger mains. From this point of view, we have also concluded that, although pipe capacities may be increased to equal approximately the capacity of new pipe, the expense of cleaning the water mains of small size as compared to the cost of installing new

and larger pipes, to replace the old mains in areas where the consumption is increasing, is not justified.

However, pipe cleaning was not deemed advisable in all cases where the loss of head was found to be high with a correspondingly low pipe coefficient. In a large number of tests, velocities were so slight that a reduction in the loss of head even to a point where the

TABLE 2

Second service zone of distribution

LOCATION	DIAMETER	LENGTH	VELOCITY	LOSS PER 1000 FEET	COEFFICIENT	REMARKS
	inches	*feet*	*feet/second*	*feet*		
Oliver Street	36	2,360	3.98	3.73	74	
North and Greenmount Avenues	36	4,100	3.43	2.32	82	
Greenmount Avenue	36	2,225	1.55	2.07	40	
Greenmount Avenue	36	1,800	0.88	0.11	110	
Greenmount Avenue	36	1,900	0.72	0.158	74	
Greenmount Avenue	36	7,350	4.39	4.74	72	
North Avenue	30	1,530	2.15	2.35	58	
Wilson Street	30	2,480	3.24	3.06	75	
Wilson Street	30	2,395	2.29	0.877	105	
Riggs Avenue	30	1,970	1.98	1.11	79	
North Avenue	36	5,440	2.59	1.73	73	
Pennsylvania Avenue	30	4,400	3.13	2.02	91	
Park Avenue	30	820	1.58	0.37	115	Short length and small total loss renders computation of coefficient uncertain
Poplar Grove Street	30	5,290	0.48	0.095	73	
Poplar Grove Street	36	1,410	1.69	0.496	93	
Poplar Grove Street	40	1,450	0.99	0.14	102	
Pennsylvania Avenue	30	2,000	1.7	0.55	100	

loss would be zero, would not increase the pressure enough to warrant the expense of cleaning. In general, the pipe coefficients obtained in our tests were less than are indicated by Williams and Hazen's tables for corresponding ages. This, however, was expected as the coefficient determinations were made with pipes under working conditions with valves, branches, bends, joints and other fittings in place.

Tables 1, 2, and 3 give the summarized data obtained on the mains in the distribution system investigated.

Many of the indicated improvements were gotten under way at once and the results showed conclusively that a survey, such as this, forms a sound basis for additions and revisions to the feeder main system, and shows where existing mains could be used to greater advantage by making comparatively few changes in the system.

In the beginning many difficulties were encountered. These difficulties had to do chiefly with the method of making measurements and the type of the measuring apparatus, but were satisfactorily

TABLE 3

Third service zone of distribution

LOCATION	DIAMETER	LENGTH	VELOCITY	LOSS PER 1000 FEET	COEFFICIENT
	inches	*feet*	*feet/second*	*feet*	
Reisterstown Road	20	10,125	2.92	1.79	117
Garrison Avenue	16	2,550	1.03	0.90	69
Garrison Avenue	20	2,550	0.64	0.47	53
Boarman Avenue	20	3,050	0.56	0.098	108
Kate Avenue	20	2,550	1.57	1.08	83
Garrison Avenue	20	650	0.65	0.154	98
Garrison Avenue	16	1,830	0.35	0.55	106
Dolefield Avenue	36	4,420	0.70	0.23	59
Park Heights Avenue	20	11,000	3.7	2.22	132
Reisterstown Road	36	11,160	0.75	0.14	82
Reisterstown Road	36	9,180	0.97	0.098	129
Druid Hill Park	20	5,700	2.08	1.95−	80
Cedar Avenue	16	9,180	3.66	4.38	104
Rolling Road	16	10,000	0.82	0.59	69

overcome. Instruments, especially for the field loss of head tests, were perfected or devised which reduced the percentage of error naturally expected in tests of this kind, due to the transfer of elevations to the pressure recording device, the short lengths of pipe under investigation, and the low velocities, all of which tend to magnify any inaccuracy in the results.

Under the old methods, the flows were often estimated without any direct measurement, or by measuring an augmented flow from the hydrants. For a loss of head test simultaneous pressure gauge readings were often the only basis for computations. The chance for error in these estimated flows, resulting in erroneous velocity com-

putations, combined with extreme difficulty in making the simultaneous pressure gauge readings, when, as is usually the case the pressures were fluctuating, made the results very questionable.

Where mercury columns could be used the same difficulty due to fluctuation of the pressure and consequent fluctuation of the mercury column made them available in only a few instances.

The combination of the pitometer for measuring the velocity with some form of pressure gauge to measure the loss of head seemed to be an ideal combination, if some of the disadvantages of the pressure gauges could be overcome.

In this work it is desirable to make a measurement of the maximum normal velocity. It is, therefore, more or less necessary to make a total flow record for twenty-four hours which will give the velocities at all times during that period. From this record the maximum velocity or the velocities at any particular times may be taken for use in studying the flow. By very few assumptions suitable additions to cover the fire requirements may be made for study and design.

For loss of head gaugings the use of the pitometer makes the measurement of the actual velocity at the time of the test very simple and accurate.

Measurement of the loss of head between each two points presented the usual difficulties of such measurements.

It was impossible on account of the high pressure encountered to use mercury columns on this work and an attempt was made to use non-recording pressure gauges. The determinations were of no value because the constant fluctuations caused serious inaccuracy in supposedly simultaneous observations.

Recording pressure gauges with 12 inch charts were substituted for the non-recording gauges. The type of gauge used was calibrated for a range of 150 feet head of water and the chart was graduated in divisions of 2 feet. These divisions were so open that it was easy to read one half foot and by reading at several points the averages were taken to tenths of a foot.

To cover the pressures in the various parts of the City of Baltimore three sets of gauges were necessary, each starting 150 feet higher than the previous gauge, thus giving a complete range of 0 to 450 feet head of water. By this arrangement the same chart spacing could be used throughout and by the use of clocks which revolved the chart once in four hours the time divisions for the tests were greatly ex-

aggerated tending to greater accuracy in comparing specified points on the charts.

In almost all cases a section of the chart showed a fairly even pressure for perhaps three to five minutes on both pressure gauges. This, of course, facilitated the comparison of the charts.

Elevations were transferred from the city bench marks to the nearest curb intersections which were usually within a few feet of the gauging points. These elevations were then transferred to gauges at the time of the test by means of a Locke hand level.

The lengths of the sections were obtained by scaling the distance between the gauging points from large scale maps of the department.

Work of this character consists of two parts: (1) The measurement of the flow under normal conditions; (2) the measurement for the loss of head between two points on a main for which the conditions may or may not be normal.

In the loss of head measurements it is usually necessary to close valves along the main under test to isolate the test section. This may result in considerable change from the normal velocity. With the valves closed simultaneous pitometer measurements are made at each end of the test section for a period of five to ten minutes to determine whether any leakage exists or if any large use is being taken from the mains between the two points.

In the case of marked discrepancies the section should be inspected for leakage and such leaks repaired if found. Also any large use should be shut off if possible for the time of the test.

Piezometer rods are then substituted for the pitometer rod meters and connected to the recording pressure gauges.

It is necessary to be especially careful to have all joints between the piezometers and the pressure gauges absolutely tight as an extremely small drip will destroy the accuracy of the reading. It is advisable to connect the pressure gauges through needle valves so that the effect of excessive fluctuations of pressure will be dampened as much as possible.

With needle valves open just sufficiently to allow the pressure gauge to operate it becomes impossible to compare extreme peaks and hollows of the charts, the steady portions alone being of value.

The pressure gauge tests should be continued long enough to get good determinations of pressure lines and this period will depend very largely on the steadiness of the flow. Usually it is advisable to run

the gaugings for about a half hour or longer to enable the operator to fix several points from which to compute the loss of head.

The data obtained from these tests give the velocity, the loss of head in the pipe plus or minus the elevation connection, and the difference of elevation. From these figures it is a simple matter to compute the value of "c" of Chezy's formula by means of a Hazen-Williams Hydraulic Slide Rule.

It has been found that the best method of recording results of a survey of this kind is directly upon a skeleton map of the trunk mains. Pitometer gauging points are marked showing the direction of flow the total, maximum and minimum flows for twenty-four hours and the maximum velocity determined during that period.

The value of "c" is also shown on each pipe section.

The velocity at the time of the loss of head test may also be recorded with "c" on the pipe, but as this is usually not a normal velocity it is rarely of value.

In making satisfactory loss of head tests in the field the difficulties are very great. Slight errors in readings of pressures, in transferring elevations from the reference point to the pressure gauge, together with short lengths of pipe and low velocities are the factors which affect the accuracy of the results.

We believe that, by the use of the type of recording pressure gauges adopted, combined with careful and conscientious operation, the error resulting from the first item can be reduced to a minimum. Assuming that elevations furnished are accurate, the only error resulting from the second item occurs in transferring the elevations to the gauge. Proper field methods will reduce this also to a minimum.

In reference to the last two factors it was noted that in almost every case where a reasonably high velocity was combined with a long length of main satisfactory results were obtained. Where, on the other hand, velocities under one foot per second were found in stretches of main under two thousand feet in length, the results were unreliable. Many of these points were retested and in one case a short length of pipe was tested by reading the loss of head directly on a U-tube; but due to the low velocity the result in this case was still unsatisfactory. In these cases a combined error of readings and elevations of only one-tenth of a foot will throw the coefficient materially one way or the other.

It must be borne in mind, however, that, where the maximum velocity is less than one foot per second, an accurate knowledge of the coefficient is not essential. The test is still of the greatest value, inasmuch as it shows that the main under normal conditions is not working to the greatest advantage and in some cases does not justify under these conditions the expense involved in its construction.

Taking into consideration the points mentioned in the preceding paragraph, we believe that the data obtained are as close to the actual conditions as is possible by the use of any instruments.

The results of a study of this character naturally suggest other avenues for investigation, but practically the results of the investigation here described, especially when taken in connection with data collected by the electrolysis, valve, pressure, and fire flow surveys, provide a definite foundation upon which it becomes possible for the water works engineer to base design for new feeder mains, in order to secure economy in operation of the plant and in the distribution of the water supply that might not otherwise be easily obtained.

THE PRESENT STATUS OF THE USE OF IODIDES IN THE MINNEAPOLIS WATER SUPPLY[1]

By Arthur F. Mellen[2]

The history of the art of water purification is a story of attempts to solve the difficulties incident to the production of a satisfactory water supply. Among the accomplishments are the removal of disease-producing organisms, turbidity, odors and tastes, the reduction of color, hardness, carbon dioxide, iron and manganese. About five years ago, however, our attention was called to a new problem, namely that many waters are deficient in iodides and that this is the cause of simple or endemic goiter.

At the 1923 Convention of the Association, Beekman C. Little, then Superintendent of the Bureau of Water of Rochester, N. Y., made the startling announcement that sodium iodide was being added to their municipal water supply for the prevention of simple goiter. Some of us had been observing in a rather detached way the accumulating evidence pointing toward a definite connection between iodide deficiency in foods and water and the prevalence of simple goiter, but here was an actual case of active coöperation between the Water and the Health Bureaus of a municipality to make use of this fact for the purpose of furnishing to its citizens a more satisfactory water supply.

Simple goiter has been known for many centuries. The Hindu literature of 2000 B.C. gives religious formulae for combating it, and the Chinese, as early as 1600 B.C. recorded methods for its treatment, using burnt sponges and seaweed ashes mixed in food. It was also well known to the ancient Greeks and Romans.

The ravages of this disease have long been recognized, but it has not been until recently that definite hopes for its ultimate eradication have been possible.

In this discussion we are interested only in the public health problem of the prevention of simple goiter. It is as definite a public health problem as is the prevention of typhoid fever or tuberculosis.

[1] Presented before the Buffalo Convention, June 11, 1926.

[2] Filtration Engineer, in Charge of Water Purification, Water Works Department, Minneapolis, Minn.

The cure of the disease is, however, in the province of the physician and surgeon.

Goiter is an enlargement of the thyroid gland, which lies at the base of the throat. There are two principal types: simple or endemic goiter, with which we will deal, and exophthalmic goiter with which the former has no necessary relationship.

The thyroid gland may be compared to the governor of an engine, because it controls the metabolism of the body, which governs normal growth and development.

The physical evidence of simple goiter is the throat enlargement, although in many cases impairment of health may result without an enlargement noticeable to the layman. This disease causes disfigurement and often results in retarded physical and mental development, causing loss of time from work and retardation in school and may result in certain forms of physical and mental degeneration such as cretinism, mutism and idiocy. The disease is especially common in adolescent girls and boys in the ages from eleven to seventeen years, being from two to three times as prevalent in girls as in boys. It is, however, often in evidence at birth and may develop in expectant mothers and at the menopause period.

Since the advent of the science of bacteriology, which is only about forty years old, scientists have tried to find a specific bacterium for each disease, but during recent years we have learned that certain diseases are caused by a lack of something such as a mineral element or a vitamin, instead of the presence of something such as certain bacteria.

Very spectacular work on the prevention of simple goiter was done by Dr. David Marine in 1909, in coöperation with the Pennsylvania State Fish Commission, on brook trout. It was found that while adult trout brought from certain localities did not have simple goiter, still the young developed it in large percentages. Dr. Marine showed that successive generations from the same fish would not have simple goiter if adequate amounts of tincture of iodine were added to the water and that the next generation from the same fish would have this disease if the iodine was withheld.

He proved that simple goiter is a deficiency disease, an ample supply of iodine being necessary to prevent it. Dr. Marine's statement that "simply goiter is the easiest of all known diseases to prevent, and it may be excluded for all practical purposes from the list of human diseases as soon as society determines to make the

effort; and it will require but a feeble effort," has been repeatedly quoted and its truth verified by the research work carried out since it was made.

The following quotation from an article by his associate, Dr. O. P. Kimball, is also significant: "No subject in preventive medicine has a sounder or more scientific basis for its practical application to man on a large scale than the subject of the prevention of simple goiter."

In 1914, Dr. E. C. Kendall of the Mayo Clinic, Rochester, Minnesota, proved that iodine is the principal element in thyroxin the iodine-containing compound of the thyroid gland, constituting about two-thirds of its total weight.

In 1916, Drs. Marine and Kimball proposed the use of iodides for the prevention of simple goiter in adolescent school children at Akron, Ohio. This was tried out with marked success.

A very interesting paper entitled "Certain Obscure Relations of Drinking Water to Disease" was given by Dr. H. E. Robertson, director, department of pathologic anatomy, Mayo Clinic, Rochester, Minnesota, before the Minnesota Section of the American Water Works Association on November 4, 1921, a part of which is quoted:

> The actual extent of our accurate knowledge in regard to the exact needs of the body and how best these needs may be served is exceedingly meagre. We know for example, that certain mineral salts are absolutely necessary, if metabolism is to be maintained at a normal balance. Calcium, sodium and potassium salts, iron, phosphorus and iodine are some of these essential constituents. Lack of calcium causes pathologic bone and tooth formation, and insufficient chlorides with serious disturbances of the equilibrium of the blood plasma are fairly well established. Iron is necessary for hemoglobin building and phosphorus plays an important rôle in the formation of many of the lipoid elements, particularly of the nervous system. Only recently it has been fairly clearly demonstrated that endemic (simple) goiter is the result of a deficient supply of iodine in the drinking water. This particular disease has long been a subject of speculation and investigation, and many years ago there was collected considerable evidence which indicated that the incidence of ordinary simple goiter (not toxic goiter) in some way was connected with the drinking water. By the work of Marine and his pupils this suspicion now becomes a certainty. Not only has goiter been produced in animals by giving them water deficient in iodine, but also by supplying to the water small quantities of this element the goiters have been caused to disappear.

This statement is of particular interest, first, because it details the need of the body for many minerals in order to maintain normal growth and development. The normal thyroid gland contains

about 10 milligrams of iodine. This is such a small amount that more than 45,000 such glands would be required to produce 1 pound of iodine. It is of interest to notice that while iron has heretofore been regarded as the element occurring in the smallest measureable amount which is needed in order that the human mechanism may function properly, still it has been found that the body needs only about $\frac{1}{100}$ as much iodine as it does iron. Second, because of the statement, "Endemic (simple) goiter is the result of a deficient supply of iodine in the drinking water." While water supplies for centuries have been suspected of having some mysterious connection with simple goiter, its true relationship was but just beginning to be accepted as a demonstrated fact by the most careful students of the subject at the time this paper was given.

When water works men learned that the prevalence of simple goiter might be due to the lack of iodides in water supplies their interest was naturally aroused, and the question arose as to whether they could be of service in correcting this condition.

Following the World War studies were made by the United States Public Health Service of the results of the draft records, from which it became evident that simple goiter is peculiarly localized in this country. Sharp lines of definition cannot be drawn, but most of the coast regions seem to be practically free from simple goiter, while there is an increase toward the center of the country, particularly in the Great Lakes Basin.

Dr. Marine, his associates and other workers had shown that simple goiter could be prevented in fish, sheep, hogs and cattle and other animals by adding iodides to the water used, but it was not until 1922 that Dr. Jesse F. McClendon, professor of physiological chemistry at the University of Minnesota, actually proved by analyses that the iodide content of waters vary widely and that there is an inverse relation between the iodide content and the prevalence of simple goiter. Later, due to the researches of Dr. McClendon and his associates, it was shown that there is not only a deficiency of iodides in the water of certain regions, but also in the vegetables, meat, milk, cereals and fruits—in short, all foods—because the mineral content of these is directly or indirectly derived from the soil. The deficiency in water then is an index of the deficiency in the foods of any locality.

It is commonly known that all mineral matter used in the body is derived from the soil. Iodides are readily soluble in water and have

been leached out of the soil by constant rains until a deficiency exists. The logical result is the high concentration of iodides found in the ocean.

Those living near the coasts have a great advantage over those in other sections of the country because sea foods which contain large quantities of iodides are commonly eaten and, too, iodides in sea spray are brought considerable distances inland by the winds, supplying iodine to the soil and hence to the foods grown on it.

It has been known for many years that chlorides are brought in from the ocean in this way, but it has not been generally realized until recently that iodides are similarly carried. The inhabitants of these regions are therefore unconsciously protected from simple goiter.

The question is then naturally raised as to why all do not have simple goiter who live in zones where the disease is prevalent. The answer is, first because of an ample supply of iodides at birth, which means that the thyroid gland of the mother was well supplied and able to furnish a sufficient quantity to the child. Second, that there are adequate quantities of iodides in the foods chosen by certain families or individuals. Third, the lack of excessive demands on the thyroid gland, which if occurring at certain periods of life may upset the balance which the iodide content in the thyroid had previously maintained.

Some have raised the question as to whether careful thyroid surveys should not be made before attempting the solution of this problem. Thyroid surveys are desirable and have been made in certain localities. This is a very slow procedure, however, demanding a skilled technique not possessed by many physicians who are not intimately familiar with the disease, and also entails a major problem of public health administration with the attendant heavy expense.

In 1924, Surgeons Olesen and Clark, of the United States Public Health Service, made a thyroid survey of 4,000 children in 13 localities in the State of Minnesota. They reported that 41 per cent of the boys and 71 per cent of the girls examined had some degree of thyroid enlargement and stated, "The results of the thyroid survey in Minnesota plainly indicate a considerable prevalence of endemic thyroid enlargement among the school children of the communities studied. *With so decided an amount of thyroid enlargement, there would appear to be ample incentive for the responsible authorities to institute iodine prophylaxis.*"

Dr. C. P. Fitch, professor of veterinary medicine at the University of Minnesota Farm School, St. Paul, says, that it is common practice to use mineral foods containing 0.2 to 0.3 per cent iodine for cattle, pigs, sheep and horses for the prevention of simple goiter, or potassium iodide may be added to the drinking water. On the farms belonging to the University of Minnesota such treatment is given consistently to pregnant animals to protect the newborn.

Successful experiments with animals naturally suggest that simple goiter might be prevented in human beings by similar methods.

There was a feeling of relief among water works men when it was found that the water supply was not wholly to blame, but there was still the question as to whether we might be able to do something to help correct the situation. Any opportunity to serve in the cause of public health could not be overlooked.

Since it is evident that an iodide deficiency exists in some localities, the question arises as to how the deficiency can be made up. Two methods may be suggested. First, let every one adopt such measures as they may think best. Second, control the amount of iodides in foods or water.

Simple goiter is a peculiar disease in that it is non-contagious and non-infectious and does not cause serious pain or inconvenience in its early stages. Since our health departments have the constant problem of trying to keep the interest of new generations of the public aroused about contagious diseases to the pitch where they will realize the danger, it seems apparent that the education of the public to care for themselves in the case of this non-contagious deficiency disease is wholly impractical.

It is evident then that the method of controlling the amount of iodides in foods or water is the only logical one.

The control of various elements entering into our diet is by no means a new proposal, in fact it is widely accepted as being necessary. Most laymen understand that scurvy and certain other diseases are caused by an unbalanced diet and that calcium phosphate is often given to children to prevent rickets, and that iron is used to combat anemia. In fact, changes in the diet suggested by a physician are usually for the purpose of adding to the individual's diet certain elements not previously obtained in sufficient quantity in his food.

Any method chosen should

1. Reach at all times those who need it.
2. Be simple as to application.

3. Be within reasonable cost.
4. Not involve complicated problems of public health administration.
5. Be immediately available.

The use of the following have been proposed as methods to make up for iodide deficiencies:

1. Sea salt.
2. Sea foods.
3. Iodide tablets.
4. Iodized table salt.
5. Iodization of public water supplies.

Sea salt does not contain iodides, because when sea water is evaporated the sodium chloride (commonly known as salt) crystallizes out, but the iodides remain in solution in the mother liquor. Sea foods, if used for their iodide content, must be chosen with discrimination, because many of them are relatively low in iodides as compared with vegetables, milk, butter, etc., in zones having ample iodides. Sea foods are, moreover, expensive and not readily obtainable where simple goiter is most prevalent.

The use of iodide tablets, as for instance in public schools, is very expensive, involves a definite problem of public health administration and does not reach the child of pre-school age or the expectant mother.

Iodized table salt is now readily obtainable and costs little, if any, more than the uniodized salt. This is a very interesting method, but cannot be considered thoroughly satisfactory until certain objections are overcome. It has been found that iodine volatilizes from the salt, with the result that manufacturers add a much larger amount than would otherwise be necessary. This, of course, introduces a factor of uncertainty as to the amount of iodides which will reach the consumer. Then, too, the writer has observed that some such salts darken on standing in a glass shaker, which would operate to lessen confidence in its use by the public. It has also been reported that in their eagerness to secure the desired iodides some people use excessive quantities of salt, which may be harmful in many cases. Should it be possible to provide a suitable iodized table salt it would be necessary to have an agreement reached by all manufacturers to maintain a certain minimum quantity of iodide in it and probably municipal, state or national legislation along this line would be necessary. This, of course, would require proper checking of the product by health authorities.

Iodization of public water supplies has an apparent shortcoming in that it reaches only those who use the supply in question, but in the case of any one city it meets all the requirements for a suitable method as required above. It assures an adequate quantity of iodides under proper supervision at all times and eliminates any special problem of public health administration. It is reasonable in cost and has the particular advantage in that it is immediately available.

It is for these reasons that it has been recommended for the city of Minneapolis by the writer. If at some future time a simpler method can be devised to reach the population of the whole State or of the Nation, such a method would be superior to the one suggested and should be adopted, but there would have been everything to gain and nothing to lose by the iodization of the water supply and protection to the public would have been given in the meantime more certainly and quickly than by any other method.

Dr. F. E. Harrington, Commissioner of Public Health and Director of School Hygiene of Minneapolis, states that there are about 20 deaths per year from preventable goiter and that because of loss of time from work, decreased efficiency at work and in school, cost of medical service, disfigurement, etc., the prevention of simple goiter is a matter of vital importance to our city, and he strongly urges the use of iodides in the public water supply.

It being advisable to use iodides in the water supply, the questions then arise as to the quantity necessary to give protection and the possible danger that some may be harmed by the quantities used. The cities of Rochester, N. Y., Sault Ste. Marie, Mich., and Virginia, Minn., are the only cities known at this time to be using iodides in water supplies. It is possible that there are others who are using it, but have not made the matter public. It may take several years in any given locality before definite results can be shown and while encouraging reports have come from Rochester, N. Y., it is too early to draw definite conclusions.

It is evidently unwise to wait until any one city has tried this method out on a suitable scale over a period of years, before instituting iodide prophylaxis. In fact, it is apparent that unconsciously this has been in use over many years on a large scale, because studies of the relation between the presence of iodides and the prevalence of simple goiter indicate quite clearly that in certain zones simple goiter is very prevalent because iodides are practically

absent, in other zones simple goiter is uncommon where the iodide content is fairly high, while in still other zones where the iodide content is very high, simple goiter is practically absent. It is seen then that certain quantities of iodides give adequate protection.

Dr. McClendon states that a water supply typical of a region having ample iodides contains about 5.0 parts per billion of iodine. The Minneapolis water supply is taken from the Mississippi River and purified in a modern filtration plant. This water contains about 0.8 of 1 part per billion of iodine. Since the deficiency in the water supply is but an index of the deficiency in foods, it is considered advisable to bring the iodides in the water supply up to 10 parts per billion, and for this purpose it is proposed to use 0.1 pound of sodium iodide per million gallons of water. It should be said that the addition of sodium iodide to a water supply will in no way change its taste or appearance or affect its value for domestic or industrial uses. The writer has drunk water containing one thousand times the amount of sodium iodide proposed without being able to detect any slightest change in the taste of the water.

The cost involved is surprisingly small. Sodium iodide is quoted for delivery in Minneapolis at $3.75 per pound. Based on the water consumption of last year and including all possible charges for equipment, overhead, etc., the cost to the city would be about $6,500, or about 1½ cents per person per year.

It is probable that from the strictly economic viewpoint this sum would be saved several times over each year by the prevention of loss of employment, cost of medical service and added expense in our school system due to retarded pupils having to repeat courses.

It is certain that if any one of the half dozen common contagious diseases could be eliminated or even controlled for several times this amount the public would heartily approve the expenditure of the necessary money.

The question of possible harm to those who do not have or would not have simple goiter is one that has been given serious consideration. Records referred to previously show that there are millions of people in this country living in zones where they have in their foods and water from 5 to 10 times as much iodide as is necessary to prevent simple goiter. It has not been until recent years that scientists have proved that such minute quantities of any element could have such far-reaching results. Sufficient data are at hand to show that quantities of iodides many times in excess of that necessary to prevent

simple goiter may be used without the slightest harm. Dr. McClendon reports that two public water supplies in California have 8,000 and 10,000 times as much iodides in them as is contained in the Lake Superior water at Duluth, Minnesota.

It is also evident that a person accustomed to the minimum quantities is not harmed by suddenly being given such small quantities as are proposed for Minneapolis, because people are moving constantly from one zone to another and there is no case on record where any slightest harm has been done in the case of a person moving from a low iodide zone to an extremely high one.

A very interesting article entitled "Iodine and Water Supplies" by Harry W. Clark, Chief Chemist, Massachusetts Department of Public Health, was published in "Water Works" for January 13, 1926, p. 44. Clark reported investigations in the state of Massachusetts on the iodide content of water supplies and sea foods. He states in this article

> I am not at all sure in my own mind, however, that this (the use of iodides in water supplies) is generally the most feasible and most reasonable method of supplying iodine. In many places, especially Michigan and Ohio, iodized table salt is now quite largely used and school children are in various places given chocolate tablets containing iodine. Certain very important studies of this method of application have been made and its beneficial results positively determined. It seems to be a simpler, more direct and more economical method than application of iodine to water supplies. . . . . In conclusion [he continues] I wish to state that application of iodine to water supplies showing a lack of this element appears to be more or less wasteful, although it may be found eventually to be the most feasible way in certain instances. The ideal way of overcoming an iodine deficiency is the use of iodized salt for table use and for use in the preparation of foods, and a greater consumption of sea foods. When we were dependent on evaporated sea water for all our salt, we probably had iodine served to us in the most simple, economical and efficient way.

While Clark expresses a definite preference for the use of iodides in salt, he has not taken pains to show wherein this method is simpler, more direct, or more economical than the use of iodides in water supplies. Neither does he prove his case that the latter method is wasteful. He states that it may be found feasible in certain instances.

His statement that salt from evaporated sea water carried ample quantities of iodine is not in accordance with the literature on this subject. As stated elsewhere in this paper, sea salt is free from iodides which remain in solution in the mother liquor.

An English point of view is reflected in an article "English Comments on Addition of Iodine to Drinking Water to Prevent Thyroidism," THIS JOURNAL, April 1926, p. 409. This is a discussion relating particularly to the procedure used at Rochester, N. Y. This writer apparently overlooks the fact that it is very possible to choose a quantity of iodides for use in water supplies such that minimum water drinkers will receive ample protection and yet copious water drinkers will be unharmed because they would ingest far smaller quantities than those who live in high iodide zones, and this furnishes the "irrefutable proof" which he wishes, that properly iodized water is harmless to the health.

This paper also raises two questions which have been asked by many who have discussed this subject with the writer, namely, as to the capacity of the body to use iodides from inorganic salts; the assumption being that our food comes principally from complex organic substances, and second, as to the possibility of danger to certain hyper-susceptible persons, in whose cases iodides appear to be contraindicated. In order to secure the best authority in answering these questions I have referred them to Dr. J. F. McClendon who has given me permission to use the following verbatim statement:

In nutrition the human body needs calcium, phosphate, sodium, chloride, potassium, bicarbonates, magnesium, sulphate, iron salts and iodide. The most easily assimilable form of all these mineral substances is as the pure salts. The body is not entirely built of them and therefore other substances are also necessary, but they may be taken separately. Thus, cod liver oil aids in building the bones, and unless the bones grow, calcium phosphate cannot be deposited, but the cod liver oil does not make the assimilation of calcium phosphate any easier.

The same is true of iron. Iron is most easily assimilated in the form of ferric chloride, but iron is retained chiefly in the red substance in the blood. The only persons who have a deficiency of iron in the diet are infants that are on an exclusive milk diet, and ferric chloride will prevent anaemia in them. It is found, however, that after great loss of blood in adults the eating of beef steak aids in the regeneration of the blood, but it is not merely the organic iron that is here effective.

Sodium iodide is best assimilated in the pure form. The giving of organic iodine preparations to normal persons is pure extravagance. Lack of sodium iodide or any substitute for it in the food or drink of children causes the thyroid gland to begin to grow. If by any chance this thyroid gland can collect enough sodium iodide or other iodine compound, the gland goes into a so-called colloid or normal stage, and the individual is functionally perfectly normal, even though the thyroid may be large. In case of failure to obtain the requisite amount of iodide, cretinism or myxedema results.

In this region over half of the school children show the beginning of enlargement of the thyroid gland. Some of these enlarging glands become otherwise abnormal. They may develop tumors or small areas of very rapid growth. These tumors (adenoma), must be removed in order to save the life of the individual. Some of them are made unfit for operation by large doses of iodides, and have to be guarded against iodides for a month before operation. Others of these enlarging glands develop a condition producing exophthalmos or "pop-eyes," in the individual. These are benefited by iodides and made better fitted for operation by large doses of iodides. There is no particular danger in feeding iodides wholesale to the population.

If a bumpy thyroid gland (adenoma) is sent to a surgeon for operation, it is his business to see that the patient does not get any iodides either in water or sea foods or any other form before operation. If a person with adenoma of the thyroid dies from the effects of this disease, the blame for the death must be placed on the failure to be operated on rather than on any supposed bad effect of iodides.

The only way to make the healthfulness of this region with regard to the thyroid gland on a par with that of the extreme southwestern and southern parts of this country, and other non-goitrous areas, is to distribute iodides in a wholesale manner.

The only medium for distribution which is now controlled by municipalities is the water supply. Sodium iodide could be placed in the water supply to the extent of 1 part per 80 million parts of water (1 pound for 10 million gallons of water), and there is nothing illegal about it because it does not make the water impure, since it cannot even be detected by the methods in which the purity of the water is tested.

Wholesale distribution of iodine by any other means necessitates legislation, therefore, it seems to me that the simplest way is to put it into the water supply.

A very thorough and valuable paper by Hercus, Benson and Carter, entitled "Endemic Goiter in New Zealand and Its Relation to the Soil-Iodine" appeared in the Journal of Hygiene (British) for December, 1925. This is a 77-page article which goes carefully into the study of the incidence of endemic goiter in New Zealand, the iodide content of soil, waters, fertilizers, etc., the distribution of iodides in spring waters and its relation to geologic formations, the iodide content of foods in goiterous and non-goiterous areas, the prophylaxis of goiter, etc.

Their results confirm conclusively the inverse relation between iodides and goiter reported by McClendon and Hathaway. It should be said that the authors favor the use of iodized salt, stating that the use of iodides in water would be too limited in application in New Zealand because it would have to be carried out by the

individual householder because of the small number of municipal supplies.

This proposal has been discussed in two of the conventions of the American Water Works Association, and a committee instructed to study this matter thoroughly has reported unanimously favorable to the iodization of public water supplies and has published its report in a chapter of the "Manual of Water Works Practice" issued during the past year.

Opposition to this or any other proposed public health measure may be expected. The Christian Scientists, who should also logically oppose all processes of water purification cannot be expected to support it. Neither can those adhering to the doctrines of such organizations as the American Medical Liberty League, whose literature asserts that the chlorination of water is unnecessary; that typhoid fever is not caused by the typhosus bacillus, and that all serums and inoculations are frauds. There are, of course, many "antis" in the realm of preventive public health just as there are in connection with social, political, religious or economic questions. It may be stated, however, that those who after careful study deliberately oppose this proposal are *largely* those who very logically oppose many or most of the fundamental principles now in general and accepted use in the administration of our municipal health departments, with which most of us are in hearty accord.

As to the actual status of the use of iodides in Minneapolis, I am reminded of the remark credited to Mark Twain, following his overhearing a heated debate about the weather in which he said, "There seems to be a whole lot said about it but mighty little done."

The previous Committee on Water Works of the Minneapolis City Council considered this matter and held public hearings. Four out of the five members of the Committee were admittedly in favor of the proposal, but for certain reasons this was never reported out of committee.

The thing of immediate interest to me is that the members of the present Committee on Water Works of our City Council are attending this Convention and are present at this time. They state that they will be guided by what they learn at Buffalo regarding the merits of this proposal.

It will be of interest to know that the Board of Public Welfare of the City of Minneapolis has unanimously approved the proposal and that the Hennepin County Medical Society (the City of Minneapolis

is practically Hennepin County) has indorsed it in the following language. "The placing in the city water supply of a sufficient amount of iodide of soda to make the city water content of iodine the same as that of cities outside the iodine-free belt."

Dr. F. E. Harrington, Commissioner of Public Health of Minneapolis, has given me permission to quote as follows from a letter from Dr. Charles H. Mayo, of the Mayo Clinic of Rochester, Minnesota. "If you would like to experiment I shall be glad to support you in it, but plan on training a few men in the examination of the thyroid. As there is no type of goiter which would be injured by the small amount of iodine obtained from the water, I do not believe there would be any risk whatever in such cases. It certainly is worth trying for the good of medicine, as such work keeps the lay people thinking of the problems of health and protection in the prevention of disease." It is said that more goiter work is done at the Mayo Clinic than at any one place in the country, and the above statement from Dr. Mayo should certainly be given due weight.

It is hoped that those interested will study this subject thoroughly and adopt the proposed plan as rapidly as they become convinced that the cause of public health will be benefited by the use of iodides in the water supply.

It is suggested that the interest of such organizations as public health associations, mothers' clubs, parent-teachers associations, etc., be gained in order that they may help bring to the attention of the proper authorities the fact that there is a definite demand for the eradication of preventable simple goiter and that a practical method to accomplish this is available.

The contributions made by Minnesota men in clarifying this subject are particularly noteworthy. Among them have been mentioned Dr. Kendall of the Mayo Clinic; Dr. Robertson, also of the Mayo Clinic, whose paper is quoted above; and particularly Dr. McClendon, who is recognized by all students of the subject to be the leading authority of the country on the iodide content of water and foods. The writer wishes to make especial acknowledgment of the kindness of Dr. J. F. McClendon, with whom he has advised frequently on this subject during the past three years, and who has made valuable suggestions regarding this paper.

In this discussion it has not been possible to refer in detail to the large volume of particularly valuable literature on this subject.

It records the story of a long quest in which many pioneers have left blazed trails.

For the benefit of those interested it may be said that for purposes of a not too exhaustive study the following authorities should be consulted: Marine, Kimball and associates for the prevention of simple goiter in animals and man; McClendon and associates for the iodine content of waters and foods; Public Health Reports of the U. S. Public Health Service, particularly articles by Drs. Taliaferro Clark and Robert Olesen, surgeons of the U. S. Public Health Service, for reports on surveys of different states and on progress made by investigators. A most interesting popular article is that of Dr. Woods Hutchinson.

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CHLORO TASTES AND THEIR ERADICATION AT DALLAS, TEXAS[1]

By O. M. Bakke[2]

Dallas receives its water supply from two main sources, the Elm Fork of the Trinity River and White Rock Lake. The water from Elm Fork is treated at the Turtle Creek plant and the water from White Rock is treated at the White Rock plant. Turtle Creek also receives some of its supply from Bachman's Dam which is not connected with Elm Fork and has a capacity of 600 million gallons. The water at Elm Fork is impounded in three reservoirs. The smallest impounds 168 million and the largest 440 million gallons. White Rock Lake was formed in 1912 by building a dam across White Rock Creek, and holds about six billion gallons. The White Rock supply is held as an auxiliary supply, used mainly in summer when the consumption is heavy, also at other times if deficient rainfall causes the supply to run low at Elm Fork, and also occasionally when the Turtle Creek plant is closed down for repairs.

The White Rock Purification Plant was completed in March, 1923. Previous to this White Rock had been used only in the fall of 1922, when sedimentation and chlorination were used. There was some doubt as to the advisability of building a purification plant at White Rock as the prolific growth of algae kept the water tasting foul during certain portions of the year. As the Elm Fork supply was becoming deficient and no other supply was available for immediate use, it was necessary to use the White Rock supply regardless of taste and odor characteristics.

From the beginning of the operation of the plant a slight taste and odor were observed, which was popularly assumed to be "chlorine" in the water. This taste became more and more noticeable up to the 10th of June, when an unusually heavy rain caused an almost complete renewal of the water in the lake. No taste was noticed for

[1] Presented before the Central States Section meeting, September 21, 1926.

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about thirty days, after which time complaints began to come in. At this time B. coli was absent in 50 cc. prior to chlorination, and the chlorine was gradually lowered to maintain a residual of 0.02 to 0.03 p.p.m. of free chlorine, but the taste increased until about the 15th of August when a strong iodoformish odor and taste was observed at the plant. About this time the taste changed to a grassy and musty taste caused by anabaena and diatoms. The plant was closed down at this time and the entire lake received a treatment of copper sulphate, averaging 0.2 p.p.m. In ten days the plant was again placed in operation and the taste due to algae direct had disappeared, but the iodoform taste was very noticeable. The chlorinator was moved so as to apply the chlorine to the secondary sedimentation basin, which provided about ten minutes contact before reaching the filters. The dose was increased so as to show a residual above the sand beds of the filters of 0.3 p.p.m. At this time our attention had not been called to results of superchlorination at New York City, and the extra amount of chlorine was added primarily to prevent aftergrowth in the filter drains. The water improved greatly in taste and odor which was apparently due to the super-chlorination treatment, and the plant was operated for several weeks without complaints.

During the same year, the plant was operated for the second time during November. It was started with a small amount of chlorine added to the filtered effluent, but the iodoform taste was so strong that the water could hardly be used for drinking purposes. The point of application of the chlorine was changed back to the secondary sedimentation basin and a residual of 0.3 p.p.m. maintained, with the result that very little taste and odor persisted and no complaints were received. The following spring, upon learning of the improvement of taste at New York by means of super-chlorination, it was decided to install a chlorinator at the pump house and to chlorinate the raw water, and also to apply chlorine to the effluent in sufficient quantity to maintain a slight residual. It was found that, if the residual of the raw water was kept at about 0.35 p.p.m., a very satisfactory effluent was obtained. The original chlorinator was too small to give residual to this extent at times, resulting in a pronounced taste being produced. This was remedied by increasing the residual from 0.08 up to 0.25 p.p.m. in the secondary chlorination applied to the filtered effluent. A sufficiently large chlorinator capacity is now available and a residual of 0.35 p.p.m. is carried in the raw water, and 0.08 to 0.10 p.p.m. in the final plant effluent. This has been

tried out at all seasons of the year with few complaints. The chlorine has between five and ten minutes contact period with the raw water before the water passes over aerators of the cascade type. Only a trace of residual remains when the water leaves the mixing channel, which is partly due to loss through aeration and partly to chlorine reduction by the ferrous sulphate applied to the aerator effluent.

It was also found at White Rock that superchlorination had no effect on certain grassy and musty tastes and odors, and that the algae growth must be controlled by copper sulphate. The first application of 0.20 p.p.m. is made early in July, and this dosage is repeated every three weeks for two months. As the plant is used intermittently, a considerable growth occurs on the filters when the plant is closed down for any length of time, or even a few days. It also occurs to some extent when the plant is operated for only eight hours per day. The effect of this growth is to give the water a sour musty taste. This trouble is eliminated by adding a solution of copper sulphate, equivalent to 2 pounds per filter, mixed by letting in some wash water, and allowing to stand for twenty-four hours, after which the filters are washed. The same method is also applied to the Turtle Creek plant, and in conjunction with pre-chlorination is absolutely effective in eliminating tastes and odors occurring when the plant is run intermittently.

The Turtle Creek plant was completed in 1914. This plant has anthracite coal instead of sand as filter media. The plant has a daily capacity of 15 million gallons per day, a sedimentation basin with a capacity of 60 million and an open clear well of the same capacity. The water has been chlorinated as it comes from the filters, but would show no residual chlorine as it is pumped into the mains, even when the filtered effluent contained as high as 0.35 p.p.m. residual. A considerable growth of bacteria occurred in the clear water reservoir, especially in warm weather. The total count of the water entering the reservoir would be from 10 to 20 per cubic centimeter, and the water entering the mains might show several hundred. A considerable increase in various gas formers was noted, and a slight increase in B. coli. This and the fact that the open reservoir was frequented by ducks and other birds and subject to other incidental outside contamination caused us to decide to try secondary chlorination of the water as it leaves the clear water basin and enters the mains. This was first put into operation in December, 1923. Pre-

vious to this time taste complaints from Turtle Creek had been due to algae. After the secondary chlorination was installed, some taste trouble was experienced, but it was difficult to locate the source as the trouble was intermittent and localized along the mains. The taste had some resemblance to the iodoform taste, but was only noticed by some people even in the districts where it was most pronounced. It could at no time be detected at the plant. Visitors to Dallas would comment, however, on the taste of the water in certain sections of the city.

At first the residual chlorine of the water going to the mains was carried at 0.05 p.p.m., but after a few months was increased so as to show between 0.10 and 0.15. Experiments were made carrying the chlorine residual as high as 0.25, but no satisfactory opinion could be arrived at, as the taste could not be detected at the plant and was always more or less transient at services where it could be detected. The general conclusion was that raising or lowering the dosage had a questionable effect on the taste. In February, 1926, L. H. Enslow, research engineer for The Chlorine Institute, Inc., became convinced that we had a rather usual taste problem, and according to his suggestions experiments were made and taste observations made carefully in parts of the city where the tastes were most frequently noticeable. The following are in brief the results obtained and conclusions deduced after the tastes had been eliminated.

The raw water at Turtle Creek is frequently very turbid and it has been found that during periods of high turbidity a considerable saving of ferrous sulphate was effected by carrying the treated water slightly caustic. On account of the large volume of water in the settling basin and clear water well, the hydroxide alkalinity generally disappeared before entering the mains. When the water remained turbid at long intervals the water entered the mains for a few days with a slight hydroxide alkalinity. As high as 15 p.p.m. hydroxide alkalinity was observed at one time in the settled water, but 4 p.p.m. was the highest going to the mains. The reason for carrying the water caustic was to effect economy and not bacterial reduction. It was noted that with the maximum amount of causticity of 15 p.p.m., after a theoretical detention period of four days, B. coli was confirmed in 10 cc. of the settled water. It was seldom that the water entered the mains caustic, but usually during periods of the year when the water was turbid the total alkalinity of the filtered water was practically all normal carbonate alkalinity.

It was found after experimentation that:

1. Chlorinated plant effluent stored for days in glass containers in the laboratory failed to develop an iodoformish taste, but did possess a flat taste such as could be observed in certain sections of the city where the newer mains had been laid. This was particularly true on dead ends or at points where there was but little flow in the mains.

2. The anthracite coal constituting the filter beds did not produce tastes when left in contact with chlorinated plant effluent or distilled water containing chlorine.

3. The residual available chlorine at various points along the mains was practically as great as that present when the water left the plant. The ortho-tolidin test, however, indicated a different combination of the available chlorine because of the considerable time (approximately 15 minutes) required for the production of maximum yellow color after adding the ortho-tolidin to the tap samples which were taken in the zones of greatest taste. Heating would accelerate the color production, but the greatest taste always accompanied the greatest length of time required for maximum color development with ortho-tolidin.

4. Addition of N/50 sulphuric acid to samples collected at the plant created a noticeable *true* chlorinous taste in the sample. Although rather noticeably chlorinous, the water was, after addition of acid, more palatable and "light" tasting and the chlorinous odor or taste rapidly dissipated on standing. The rapid disappearance of "free" chlorine was likewise indicated by the residual chlorine test.

As a result of these observations it was concluded that:

1. When sufficient normal carbonate was present in the filtered water, i.e., when the pH was sufficiently high, the applied chlorine produced hypochlorites and most probably chlor-amines also.

2. These chlorine products held fast to their available chlorine in the high pH medium and in absence of sufficient half-bound carbon dioxide to cause release of the chlorine. Such stabilized chlorine compounds would therefore persist for many hours in the mains.

3. These compounds were responsible for the "flat" tastes prevailing at the plant and in the newer sections of the city. Further, the iodoformish taste in the older sections was produced as a result of the stable compounds containing available chlorine. Taste producing compounds were being formed through action of these stable

compounds on the pipe coating, or perhaps through contact with slime deposits, within the older mains.

4. The reason for intermittent appearance and disappearance of intense tastes was to be found in the fact that the pH of the treated-filtered water varied as a result of varying the lime dosage applied to the water to meet operating conditions, as previously stated.

5. Increasing or decreasing the total chlorine dosage at the plant produced no noticeable change in taste conditions at the services as long as 0.10 p.p.m. or more residual chlorine was maintained in the water leaving the plant.

6. Reduction of the lime applied to the water and increase of coagulant (ferrous sulphate) would produce a clearer effluent and at the same time one containing sufficient bicarbonate content, not only to prevent the formation of stabilized chlorine products, but at the same time allow greater rapidity of dissipation of the available chlorine present.

7. Re-carbonation of the settled water ahead of filters, or the filtered effluent, would accomplish the same desired effect when it was necessary to apply lime sufficient to produce caustic alkalinity at the filter.

8. Providing this effect to increase the rate of available chlorine dissipation was produced, the water would no longer possess the slightly medicated taste in the newer sections, nor would the available chlorine be present in sufficient concentration when the water reached the older sections of the city to cause production of the by-products which impart the iodoformish tastes to the water at the services.

To place the above suppositions into practice, the first step taken was the gradual reduction of the lime dosage. This necessitated an increase of coagulant (ferrous sulphate) in order to effect adequate clarification and rapid filtration. Neither the primary chlorine dosage applied to the filter effluent entering the clear water reservoir nor the secondary dosage applied to the main leaving the filtered water basin was changed.

The decreased lime and increased ferrous sulphate dosage produced a filter effluent containing between 30 and 40 parts per million bicarbonate alkalinity and only 10 to 20 parts per million of normal carbonate alkalinity. The total hardness showed an increase of only 10 to 15 parts per million. The residual chlorine in the water leaving

the plant remained between 0.10 and 0.15 p.p.m. after a period of contact of 10 minutes.

The tastes at the sampling points did not immediately disappear because of the gradual reduction of the lime dosage. After approximately ten days of the trial run and utimate lowering of the normal carbonate in the finished water to an average of 15 p.p.m. the tastes had entirely disappeared in most sections of the city and almost completely in that section productive of the most trouble. Little, if any, residual chlorine now exists in tap samples at any appreciable distance from the plant. Where a slight residual is found, however, little, if any, by-product taste can be detected. Since the first two weeks of the new treatment program no complaints have been received. To the contrary, the improved taste has been remarked upon by persons unaware of the change in treatment.

Although somewhat more costly during periods of very turbid water, when greater quantities of ferrous sulphate are required in lieu of increased lime dosage, the change of treatment has unquestionably eliminated the cause of taste troubles at Dallas.

Probably the more economical procedure to follow will be found in the use of larger quantities of lime when required for most economical coagulation and re-carbonation ahead of the filters when necessary.

The author wishes to acknowledge the helpful assistance rendered by Edgar Whedbee, District Engineer of The Texas State Department of Health, and the service rendered by The Chlorine Institute of New York City.

LAKE ERIE AS A PUBLIC WATER SUPPLY[1]

By Howell Wright[2]

Lake Erie is manifold in its blessings—commerce, industry, shipping, recreation. It is a local, interstate and international highway —a public water supply. In this last respect, no doubt, it yields its greatest benefits to humanity. Lake Erie and its tributaries provide water for domestic and industrial uses and for fire protection to at least 25 cities located in four states in this country and to a dozen cities in the Dominion of Canada. The total population thus provided is estimated at about 4,000,000. Less than twenty years ago, water was used by the population on the banks of the Lake in its natural state for many purposes. Today, as a result of the growth of population, of industry and commerce and shipping, it is treated by artificial process by many cities and towns.

Detroit, Wyandotte, Michigan—Sandusky, Vermillion, Elyria, Lorain, Cleveland, Painsville, Ashtabula, Conneaut, Ohio—Erie, Pa., and Lackawanna, Dunkirk, Buffalo, New York, all purify their water supply by the aid of rapid sand filter plants. In Canada, Walkersville and Windsor chlorinate their water supply; Amherstburg has a filter plant; and seven cities, known as the Essex Border Utilities, are soon to have a filter plant in operation.

Lake Erie is the natural drainage body for 25,000 square miles of territory. With its tributaries, it serves as the natural receptacle for the domestic sewage and trade wastes of a population in excess of four million. This population is increasing rapidly and it is believed will continue to increase.

For many years this dual use of the Lake by advancing civilization presented no serious problem. Today the resulting problems are numerous. Rapidly advancing pollution now seriously affects (1) the lake as a source of public water supply, (2) the sanitary condition of public and private bathing beaches, (3) property values on the shores, and (4) the fishing industry.

[1] Presented before the Central States Section meeting, September 21, 1926.

[2] Director of Public Utilities, Cleveland, Ohio.

Far less attention has been given to prevention of pollution by trade wastes and domestic sewage and to its control than to purification of the water after pollution.

Sandusky has a sewage disposal plant which is not in use. Cleveland has partial treatment in two lake front plants and one plant for complete treatment being built on the Cuyahoga River. Ashtabula has a rough screening and chlorination plant. Lackawanna, New York, has settling tanks and contact beds. Of the larger American cities, Detroit has no sewage treatment works; Buffalo has none; Erie has none and Toledo has none. Practically nothing, taking the territory as a whole, is being done by way of sewage purification on Lake Erie and not much more by way of sewage treatment.

LOCATION OF WATER INTAKES AND SEWAGE OUTFALLS

The location of water intakes and sewage outfalls in the same body of water presents interesting and complicated problems. It shows at a common sense glance how closely related are the problems of water purification and sewage treatment on Lake Erie. The solution of one to a marked degree depends upon the solution of the other.

In the smaller cities, water intakes are usually only a few thousand, and sometimes only a few hundred, feet from the shore. Cleveland's intakes are four to four and a half miles from the shore. On the Detroit and Niagara Rivers (inlet and outlet to Lake) the intakes are necessarily quite close to the shore. It is well known that in some localities water intakes and sewer outfalls are in too close proximity.

OLD THEORY OF LOCATION

It is interesting to note in going over the history of the struggle to secure an adequate supply of pure water in this region how plans have been suggested (and tried out) for the control of community wastes through the location of sewage outlets so placed as to pass the "benefits" of the pollution on to the next community neighbor. All will agree, I am sure, that this day has gone forever.

It is indecent for a community to pollute its water supply with its own sewage; it is an interstate insult to pass it on to your bordering State neighbor and, since Lake Erie is an international waterway,

it is inconsistent with the principles of international comity to allow uncontrolled pollution of either shore or boundary waters.

THE INTER-RELATION OF WATER PURIFICATION AND SEWAGE TREATMENT

State and local authorities have given some recognition to the dangers of community domestic sewage and trade wastes. Its menace to the public water supply has been minimized, however, in the past and is so minimized too frequently now. The problem has been considered largely from the point of view of a nuisance—the dangers likely to accrue to persons living on polluted streams or lakes and to bathers on public bathing beaches. Sewers and sewage disposal and treatment are even now considered as having little or no relation to the public water supply. Slowness in the development of the sewage treatment art and "tradition" are largely responsible for this. In this connection, I commend to your attention the timely paper by George A. Johnson, Consulting Engineer of New York City, in a recent issue of the American City magazine on "Sewage Purification—Real and Delusive." We have already had too much "delusive" sewage purification of Lake Erie.

The facts, however, as to Lake Erie, if considered sanely, will convince anyone, who is willing to be convinced, that the menace to the future water supply of Lake Erie is such as to call for statesmanship of the highest order in its solution. Regardless of "tradition" and custom, it must breathe a new spirit which emphasizes the fact that the problems of water purification and sewage treatment are inseparable and must, therefore, be solved together.

THE CLEVELAND SITUATION

Let me illustrate what I mean by the situation in Cleveland. In so doing, let it be understood that I am not discussing persons or unduly criticizing past policies. I am commenting upon policies, the results of which seem to be wholly inadequate for the solution of a great problem. The emphasis heretofore has been wrong. I am using the illustration to advocate the carrying out of a broader community policy locally, but which is fundamental in its application to the Lake problem as a whole.

Let me say here that the inseparable problems of water purification and sewage treatment have been fully recognized by City

Manager Wm. R. Hopkins. Their joint solution has been emphasized and demanded by him. And with respect to the control of trade wastes, he has accomplished, in two years, more than has been done here in a dozen previous years. In all matters relating to control of sewage and industrial wastes, he has emphasized the public water supply as the first consideration.

In sixty-eight years Cleveland's first water intake (built in 1854) has been moved from 400 feet off shore to four and a half miles into the lake. A second tunnel has been built also in that time, with its intake located at the same distance from shore. The history of the location of our intakes is the history of the encroachment of our own sewage pollution upon our own water supply.

Cleveland did not filter any of its water until 1918 and not until 1925 (October) did it obtain a 100 per cent supply of filtered water for the Metropolitan district. It undertook water purification first and partial sewage treatment last. Like other cities it has not observed the time-old maxim "an ounce of prevention is worth a pound of cure."

Sewage treatment in Cleveland became a fact in 1921 but only to a limited degree. It was adopted following orders of the Ohio State Department of Health in 1912 to build plants for the purpose of protecting bathers on the beaches and to prevent a nuisance. Cleveland now has two partial treatment plants on the Lake front and is building a third plant with complete treatment processes on the Cuyahoga River, 15 miles from the water intakes in the Lake. In our Westerly plant we remove screenings and grit, provide Imhoff tank treatment and chlorinate during three months of the year. At our Easterly plant we remove screenings and grit and chlorinate during three months of the year.

And in what position do we find ourselves? Cleveland has the best water supply in its history, but the problem is to keep it safe by the process of prevention and complete control of its sewage and trade wastes. With us, as with other large cities, much must be actually accomplished in the next five years.

The population is growing; the sewage menace is increasing. We need complete treatment of all our sewage, but we have no land at these two plants for this purpose and can get little except by making it. And we are planning a new Boulevard on the Lake front which will pass these plants. If it is practical, we must change them into pumping stations and pump our sewage elsewhere back from the

Lake for treatment. Or we must make the land and provide the most modern and complete treatment that science can devise to protect our water supply, our lake front property and our bathers.

It will be a hard battle. But other cities on the Lake are facing and must face the same difficulties. Detroit, Toledo, Buffalo and other cities are confronted with similar situations now. Will they be misled by the traditions of "nuisance" and "bathing beaches" or will they look ahead and do the big thing of conserving Lake Erie as a water supply for themselves, for their neighbors and future generations? The very excellent report for the City of Detroit by Messrs. H. P. Eddy, John H. Gregory and Clarence W. Hubbell, recommends only partial treatment. Is what they recommend sufficient for the complete protection of their neighbors from Detroit's sewage? Buffalo may not need sewage treatment for its own purposes now. It discharges its sewage "into the Niagara River and its tributary, the Buffalo River." But the city of Niagara Falls, at least, is not thus protected. Detroit and Buffalo are typical instances of what I mean by the "passing on to your neighbors" theory.

As helpful guides, I recommend to you the studies of the late Professor George C. Whipple (1904), the extensive investigation of the experts for the International Joint Commission on the Pollution of Boundary Waters, and the recent studies of local pollution by J. W. Ellms (1920–1924) and D. E. Davis at Cleveland and Erie, respectively.

SCOPE OF THE PROBLEM

This is not a local and state matter only. It has both Federal and International aspects. In 1914 there was an investigation by a Joint International Commission on the Pollution of Boundary Waters. The investigation was limited in scope. Its findings were that the pollution

> is very intense along the shores of the Detroit and Niagara Rivers and in the contaminated areas in the Lakes. Throughout the whole length of the boundary waters where sewage is discharged from the sewerage works of cities and towns the pollution is most concentrated in the shore waters on the side of the boundary on which it originates. These shore waters, besides being in places unsightly, malodorous, and absolutely unfit for domestic purposes, are a source of serious danger to summer residents, bathers and others who frequent the localities. So foul are they in many places that municipal ordinances have been passed prohibiting bathing in them.

Since then there has been an increase of population on Lake Erie, but the prevention and control of sewage pollution has not developed as the facts would seem to require. This might well again be made the subject of an inquiry which would investigate the shore pollution of the waters of the Great Lakes. I hope this Association will so recommend to the proper Federal authorities; namely, the United States Public Health Service or the State Department and Congress.

FEDERAL INVESTIGATION

Your attention is also called to the recent investigation and report by the Chief of Engineers of the United States Army on the pollution of navigable waters. Read the statement of the effects of pollution of Lake Erie by domestic sewage and trade wastes upon the fishing industry and draw your own conclusions as to the possible and probable effect upon the public water supply. I will read but one paragraph from page 24 of this report:

> The pollution of waterways affects not only the fisheries therein but also the public health, sports, and various forms of outdoor recreation. The waters are used by the general public for domestic commercial, industrial, recreational, and other purposes. They have been used for the disposal of domestic and industrial wastes since the settlement and industrial development of the United States began. What constitutes the highest and most economic use of a waterway aside from its use as a public highway of commerce is a problem the solution of which involves a study of local conditions and the proper adjustment of the various conflicting interests of the locality. The growth and industrial development of a locality may depend upon the use of its streams for economical disposition of its domestic and industrial wastes; and should the pollution of streams in such a locality be prohibited, the future development of the section might be seriously impaired. As a general rule the value of the products of the fisheries is small as compared to the total value of the products of all the industries which use the waters for other purposes. The problem therefore resolves itself into a determination of the use of each waterway which will result in the greatest benefit to the community. It is believed that should the Federal Government undertake the control of pollution generally there might be a tendency on the part of the State and local authorities to relax their efforts to study the problem and to enforce the local laws, with the result that the entire problem would be left to the Federal Government, which would be confronted with the necessity for providing a large organization to cope with the many local problems which would arise.

It is plain to be seen that unless the local and State authorities exert themselves to a greater degree in these matters of stream and

Lake pollution, we will eventually have the Federal government dealing with it. The intervention on the part of the Federal Government may be in the interest of industry and commerce at first, but it will have its effect upon the water supply and the public health.

THE DUTY OF THIS SECTION OF THE AMERICAN WATER WORKS ASSOCIATION

This section (The Central States Section) of the American Water Works Association should take an active interest in these inseparable problems of water purification and sewage treatment as related to Lake Erie.

1. We must understand that we are not concerned solely with the mechanics and hydraulics of water supply. We have something else to think of besides pumps and mains and reservoirs. We water works officials are concerned with the big problem of obtaining an *adequate* supply of *pure* water for all purposes for our respective communities.

2. This means (and especially so where sewage outfalls and water intakes are within the same body of water) that we must be constructively concerned with:

a. The prevention and control of pollution by trade wastes.

b. Adequate and modern methods of sewage treatment and real purification.

c. Filtration and disinfection of the water used by the public.

3. We must not hesitate to discard, if necessary, the old traditions of sewage treatment and make the art fully effective as applied to the protection of our natural waters from sewage and trade waste pollution.

4. We must watch State legislative proposals affecting trade wastes, sewage control and the public water supply. Legislation intended for rural counties, but having State wide application may be very injurious to the interests of large cities or communities confronted by exceptional conditions.

5. We must try to do our part in insisting that engineers of State departments having authority over matters pertaining to sewage and water in our cities, and especially Lake cities, are fully awake to the importance of these problems. State departments that do not recognize and emphasize the relation of sewage pollution to water supply, especially as regards Lake Erie are not alive to the true significance of the situation.

6. We must wake up. We must see that the fundamental principles of conservation are applied effectively to Lake Erie and that the precious heritage of this public water supply is guarded and protected and made safe for ourselves, our neighbors and future generations.

THE CASE OF THE PEOPLE—PUBLIC HEALTH VS. WATER[1]

By H. E. Moses[2]

THE INDICTMENT

In preparing a case for presentation to the court, the prosecuting attorney draws a bill of complaint known as the indictment. In this he sets forth with circumstantial detail the charge against the unfortunate caught in the toils of the law and lays the foundation for his case. Let us consider the facts in the present case of Public Health vs. Water.

In the pre-Volsteadian days, a southern colonel responding impromptu to a toast on "Water" summed up in an eloquent fashion the feeling held by some persons who consider water other than as a thirst quencher. Responding, he said:

> *Water*—the purest and best of all things that God created.
>
> I want to say to you that I have seen it glisten in tiny tear drops on the sleeping lids of infants.
>
> I have seen it trickle down the blushing cheeks of youth and go in rushing torrents down the wrinkled cheeks of age.
>
> I have seen it in tiny dewdrops like polished diamonds when the morning sun burst in resplendent glory o'er the eastern hills.
>
> I have seen it in the rushing stream rippling over pebbly bottoms, in the river rushing over precipitous falls in its mad rush to join the mighty Father of Waters and I have seen it in the mighty ocean on whose broad bosom float the battle fleets of all nations and the commerce of the world—
>
> But—ladies and gentlemen, I want to say to you now, that as a beverage it's a damn failure.

Latterly it has, perforce, come to a more exalted station as a beverage, even among those who formerly considered that its chief function was to act as a "chaser" after a draught of liquid more pleasing to their jaded palates and certainly more potent in its reaction.

But there are still other critics, carping, perhaps, in the opinion of

[1] Presented before the Central States Section meeting, September 22, 1926.

[2] Assistant Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.

the waterworks operator, whose business and pleasure it is to continuously supply this wonderful fluid essential to life.

Occasionally minute organisms choose a public water supply reservoir as a home in which to live, breed prodigiously and die. They are not overly particular as to their habits and frequently cause odors and tastes in the water suggestive of unpleasant things. Then the telephone wires to the water company office fairly hum and the manager talks soothingly and gives a heroic example of self-restraint.

The average American has become accustomed to refinements of living undreamed of by his ancestors. He is no longer satisfied with water that is merely palatable and of good appearance. But he registers a hearty kick if it has excessive hardness, is perceptibly colored, corrodes his plumbing equipment or causes stain on the porcelain fixtures and clothes in the laundry. This latter immediately raises the righteous wrath of the outraged housewife. And again the water superintendent has a bad day, causing his children to run to cover when he reaches home.

And finally the most serious charge is that the public water supply is a vehicle for transmitting death-dealing disease to innocent ones.

THE EVIDENCE

It is a far cry to the first public water supply in the United States installed in 1652 at Boston, 274 years ago. This was the first of the various public utilities to be established in the United States, gas following in 1816 at Baltimore. Forty years before the signing of the Declaration of Independence, in 1736, Pennsylvania saw its first public waterworks at Schaefferstown and still operating, 190 years old. Not until 25 years later—in 1761—did this country see its first waterworks pumps at Bethlehem, Pennsylvania—begun in 1754 and completed in 1761.

In 1800, there were only 17 waterworks in the United States. Not for 50 years afterwards did the number pass the hundred mark. Beginning in 1875—when there were only 243 waterworks in the United States—rapid growth began. One thousand in 1885, nearly 3000 in 1895 and in 1925, over 9000 waterworks in the United States, supplying 10,000 communities and many millions of people. In Pennsylvania alone, there are 650 public waterworks, supplying more than six million people.

Our forefathers, many times our foremothers, with back-breaking toil supplied the water for the household from the nearest spring or

well. Today in every modern home, water flows freely from convenient faucets; it sprinkles our lawns, extinguishes fires and turns the wheels of industry. The province of the waterworks management is to insure this supply against failure, prevent the presence of objectionable constituents and, most of all, the insidious germs of disease.

This rapid expansion of waterworks service brought its attendant problems. Rather early, the occurrence of severe typhoid fever outbreaks forcibly directed the public attention to water as a mode of transmission of this dreaded disease. Efforts at control were made by means of watershed protection, but the epidemics continued and the futility of measures that stopped short of purification was realized. So we have the growth, first of filtration, later of chlorination. Their beneficial effect is now taken as a matter of course and as an accepted practice in waterworks management. To such an extent has this proceeded that the feeling is now quite general that no surface supply can be considered safe unless it is protected by at least chlorination, even though defensive measures on the watershed are adopted.

It is hard to realize today, with filter plants in general use, that only 56 years ago—in 1870—the first real filter plant was built in the United States. This was of the slow sand type—built at Poughkeepsie, New York, the second following at Hudson, New York, five years later. Today there are nearly 600 rapid and about 50 slow sand filters in use on public water supplies in America, with a total capacity of 5000 million gallons per day.

Nearly half of this capacity is to be found in the four states represented at this Convention, Michigan having in daily capacity 463 million gallons, West Virginia 99, Ohio 743 and Pennsylvania 911—a total of 2216 million gallons daily, this including only plants of one million gallons per day or over. Pennsylvania has built 26 new plants in the past four years, a total of 179, serving nearly 5,000,000 people.

Chlorination of public supplies started later—in 1908—but has had a more rapid growth, in 18 years expanding from a single installation to about 3000 treating nearly 4000 million gallons of water daily. In Pennsylvania it was first used on unfiltered water at Erie on March 15, 1911 at the time of a disastrous typhoid fever epidemic. Today we have 370 such installations, 94 having been introduced during the past four years.

Every waterworks man knows of the effect this has had on the reduction in typhoid fever, in which decline the most important factor has been the improvement in public water supplies, principally by filtration and chlorination. A brief résumé of the situation for the United States at large and for Pennsylvania in particular will serve to illustrate this fact.

In 1900 the death rate from typhoid fever in the registration area of the United States was 35.9 per 100,000 population. In 1924 it was 6.7 a reduction of approximately 81 per cent.

The Journal of the American Medical Association since 1913 has presented a summary of typhoid fever death rates in cities of the United States of over 100,000 population. More than one-quarter of the country's residents live in these cities and the data compiled show the universal decline of typhoid in these large centers of population. Fifty-seven cities in 1910 had 21 million population and a typhoid death rate per 100,000 of 19.61. In 1925 (59 cities), with a population of nearly 29 million, the rate had fallen to 3.43. This was higher than the three preceding years, but 1925 was known as a "typhoid year."

In Pennsylvania, as elsewhere, it required the occurrence of severe epidemics to bring about the enactment of adequate health laws. Serious epidemics occurred in the State; the first of record in 1885 at Plymouth, a mining town of 8000 inhabitants, where 1104 persons contracted the disease and 114 died. An infected public water supply was the cause.

The next large epidemic ascribed to a contaminated public water supply occurred in Butler in 1903. Here in a town of 18,000 population there were 1384 cases with 111 deaths. The following year the State Legislature passed the law creating the Pennsylvania Department of Health, giving it jurisdiction over public waterworks.

Other epidemics followed, but as indicative of the results of the control of typhoid fever exercised by the State Department of Health it may be stated that in 1906 there were 3917 deaths from typhoid fever and the rate of 54.8 per 100,000 population. In 1925, there were 448 deaths from this disease, representing 2437 cases, a death rate of 4.8, a reduction over the 1906 rate of more than 90 per cent, equivalent to a saving of 50,000 lives.

Doubtless this record can be matched in other states and is cited merely to show the wonderful reduction in typhoid fever for which improved public water supplies should receive credit in full measure.

With typhoid fever reasonably under control in the larger centers of population, attention must be directed to reduction of this disease in the rural sections of the State. Here with the cases scattered over a considerable territory, the problem of tracing the source of infection is more difficult than in the urban communities. Speaking of Pennsylvania, and the same may be true of other states, the case rate since 1909 has been higher in the country than in the urban districts. In this connection there is a feature that is of special interest to waterworks men; namely, the fact that cases infected in the country districts are charged against the town or city, thereby increasing the urban rate and possibly reflecting discredit upon the public water supply.

Country dwellers contracting typhoid are more frequently than ever brought into the city hospitals and through laxity in the method of reporting are charged against the city total, rather than on the basis of the place of infection. The increasing use of the automobile has a marked bearing on this matter. The urban dweller travels far from his own home and contracts the disease many miles distant. Returning he is taken ill and the source of infection is extremely difficult to ascertain. To cite only one instance will illustrate the point. In Scranton, Pennsylvania in 1925, there were 24 cases of typhoid, 7 of these lived outside the city and were taken to the Scranton Hospital. Thirteen of the remaining 17 had been out of the city previous to their illness, leaving only 4 who could probably be charged as bona fide city cases. As a matter of fact they were all included in the Scranton records.

This is not wholly due to the fault in reporting since ofttimes a final diagnosis of the case is not made at the place of residence, but with the patient quite ill hospitalization is deemed wise and the fact that he has typhoid fever is not fully disclosed until after he reaches the hospital when the health report is sent in.

Along the same line the speaker recalls that a few years ago one of the cities in the eastern part of Pennsylvania was charged with a considerable number of typhoid fever cases, thereby giving a black mark, when as a matter of fact the greater part of them were employees of a concern in an adjacent town and were infected in the factory during an epidemic and simply because they were residents of the city in question the typhoid was charged against that municipality.

This points to the necessity of a careful study of typhoid cases to determine the real source of infection rather than to accept what

may be an easy solution by placing the public water supply under suspicion as the public is prone to do when typhoid cases appear in any numbers in a community having a public supply. The waterworks management in self defense must insist that this be done by the health authorities and offer every possible aid to that end.

Brief reference only will be made to other tendencies in waterworks practice to point out the recognition that is being given certain factors because of their effect on the public.

The travelling public is being protected on common carriers engaged in interstate traffic—trains and steamboats—by the issuance of certificates by the United States Public Health Service for water used for drinking and culinary purposes. These are based on approval first by the respective State Health Departments.

The health of the tourists who traverse our highways in ever increasing number is safeguarded by the campaigns inaugurated by several of the states for the examination and the approval or condemnation of the roadside water supplies to which they must resort. In some states the work is furthered by the use of motorized travelling laboratories.

Chance contamination of public supplies may occur through cross connections forming an inferior supply to a drinking water supply. The trend of opinion is absolutely to forbid such devices. At the last American Water Works Convention a forward step in this direction was officially taken.

Experience has demonstrated that when offensive tastes and odors are present in a public water supply, even though it may be bacteriologically satisfactory, the people will not drink the offensive water, but will resort to unknown and ofttimes dangerous waters, such as from springs, wells, or bottled waters which are palatable but may not be pure. A public health problem thus arises and points to the necessity of supplying at all times a satisfactory water through the public system.

Such a case occurred in Pennsylvania this year. The public supply was offensive. The people resorted to wells and springs. Out of 200 of these only 6 or 7 tested satisfactorily.

Recognition is given to many of these factors. Research work is being carried on at various plants to devise practical methods of handling difficult waters, rectifying plants are being built, certain operations are being adjusted by the pH yard stick—in fact some chemists are fast acquiring a pH complex.

In general, there seems a tendency to meet these problems face to face and endeavor to solve them satisfactorily. The exchange of views in meetings such as this cannot fail to be helpful.

Bathing has become a habit with our people and for this they want proper water. If cleanliness is next to Godliness, then the modern hotel—1000 rooms and 1000 baths—is akin to the house of worship. The first bath tub in the United States was built in Cincinnati in 1842 and was denounced by the newspapers as a luxurious and undemocratic vanity. Some medical men pronounced it a menace to health. It is said that Philadelphia in 1843 and Boston in 1845 made bathing unlawful. Today we have a society known as the American Association for Promoting Hygiene and Public Baths. Swimming pools and bathing beaches are springing up like mushrooms.

Some persons are disposed to place the entire burden of producing a safe and satisfactory water supply on the water purveyor, while at the same time the municipalities and industries are grossly contaminating the sources of supply, thereby rendering the waterworks task well-nigh impossible. Latterly, however, has come a realization that each has a responsibility and should share the burden. Much attention is being given to questions of stream pollution and to development of practicable and reasonable means for controlling or correcting them. A significant movement is the approach being made in some instances by agreements between states.

In Pennsylvania, the problem of stream pollution is being approached in a comprehensive way by the Sanitary Water Board, which early realized the magnitude of the task and one of its first acts was to set up a classification of streams, making three divisions known as Class A, B and C respectively. Class A are relatively clean streams; Class C are those representing the other extreme, where streams have been in some instances so grossly contaminated as to be unfit for either domestic or industrial use. In between are the Class B streams embracing by far the larger number, where determination must be made as to the use to which the stream will be put, keeping in mind that generally the highest use of the stream is as a source of public water supply. This Board by coöperation with industry is studying some of the problems of industrial waste, among which may be mentioned those from tanneries and from pulp and paper wastes. It is the purpose of the Board to undertake studies of other industrial wastes later on.

THE VERDICT

In justice the verdict should be rendered according to the evidence produced. The speaker has attempted briefly to review the history of waterworks development, its successes as well as some of its failures. The end is not in sight, contrary to the opinion of some who are inclined to suggest that there will be no further marked advance in the art. However, the research work now being carried on and the eagerness of the waterworks fraternity to undertake new studies and the disposition on the part of the management to increase facilities, all to the end that a safer and more pleasing supply may be furnished continuously to consumers are good omens. The willingness of the management to take the public into its confidence, which was not the case a few years ago, is evidence of a better understanding between the two and bespeaks a still closer bond in the future. Educational propaganda can do much to break down the mistrust that is often felt where public utilities are concerned.

It would not be fitting to close this paper without paying tribute to the zeal and devotion to duty of the men engaged in waterworks production. There are no hours in this business, since emergencies frequently arise and must be met immediately and it is largely due to the unswerving fidelity of waterworks employes from the manager down to the humblest laborer, that has brought about the wonderful expansion in this business and has produced the gratifying results in the reduction of typhoid fever in the United States, which alone would be an accomplishment worthy of the utmost endeavor.

TESTS OF CAST IRON PIPE[1]

A Discussion

Thos. H. Wiggin:[2] This series of tests which Professor Talbot has made is the first set of tests that have shown, in a comprehensive way, the physical properties of cast iron pipe tested and their relation to the test bar. These tests, of course, cover only 6-inch pipe, and in order to cover the field, similar tests must be made on a number of other sizes. A series of tests of this kind takes a long time and costs considerable money, but it is hoped that the new Sectional Committee on Cast Iron Pipe will have the facilities to go further with tests of this kind and to cover larger sizes as well.

There is one other important load which comes upon pipe that is not at all new to Professor Talbot because he has discussed it both for cast iron and for other kinds of pipe, and that is the earth load. Members of this Association will perhaps remember Mr. Hazen's paper of some ten years ago, which proposed that not only the water pressure in the pipe, but also the earth pressure should be taken into account in determining what thickness of pipe should be used for a given condition. Few engineers go as far as Mr. Hazen, I think, but it is generally agreed that, for at least the larger sizes where earth cover is more than normal, additional thickness should be provided. For ordinary cover most engineers regard the earth load as being provided for by the factor of safety.

The factor of safety in 6-inch pipes against water pressure has been shown by Professor Talbot's tests to be very large. Small pipes obviously can easily take care of pressures of 100 or 200 pounds per square inch and leave something to spare for the earth load; furthermore, a 6-inch pipe has not much earth load. When the pipe is large the factor of safety against water pressure is reduced, and also the effect of the earth pressure has become large, so that in compre-

[1] Discussion of paper by Authur N. Talbot on "Strength Properties of Cast Iron Pipe made by Different Processes as Found by Tests," Journal, July, 1926, page 1.

[2] Consulting Engineer, New York, N. Y.

hensive tests for the larger sizes some attention must be paid to the earth load as well, which will introduce complications in the additional series of tests beyond those of Professor Talbot's tests on 6-inch pipe.

The various societies have been struggling for fifteen or twenty years with the question of test bars. Everybody knows, who has given it any study, that the test bar is not a test of the pipe at all, but merely a test of the bar, and that the iron in the pipe is generally quite different from that in the bar, owing to a different rate of cooling and consequently different character of crystallization. On the other hand Professor Talbot's tests of pipe were direct; he tested strips cut longitudinally from the pipe and rings obtained by cutting very short pieces from the pipe as well as testing the pipe itself to destruction by water pressure and by impact. These tests give a great many indications as to the quality of the pipe which could not by any possibility be obtained by testing the test bars alone.

The question is, what will be the practical test of the future, to determine the nature of pipe in regard to its suitability for use? One of the tests that has been suggested by Professor Talbot is the strip cut from the pipe. That of course would be a very excellent test; however, it destroys a considerable length of pipe. Still, if a dozen or fifteen pipes are cast and one is wrong in some minor particular and has to be rejected, this defective pipe would frequently be suitable for making a test of this kind. On the other hand, the iron from a cupola, used to melt iron for a lot of pipes, not infrequently varies considerably during a day and a test of only one pipe is not sufficient to represent the whole output.

I have been somewhat hopeful of the ring test and was sorry to see that it gave such a poor showing in these tests by Professor Talbot. I have been wondering whether the ring test would not yield more consistent results if tested in segments, so that the influence of different thicknesses around the ring could be allowed for; the separate testing of the several segments would give as well a precision measurement of the test. Ring tests could be made without sacrificing a pipe.

Whatever new tests, if any, may be adopted as the result of studies now being made should, I think, be correlated with the old tests by continuing the 2-inch by 1-inch test bar for a considerable period. Foundry men are developing the round "arbitration" bar more and more as a general test of the iron which is being supplied from the

cupola. The A. S. T. M. and similar foreign bodies are drawing together in the details of this round arbitration bar and it also must be considered in comparirg irons for different purposes. But the user of pipe, practically never a metallurgist and having no metallurgical representative at the foundry, needs the more tangible and direct tests of the product he is buying and it is hoped that Professor Talbot's tests will supply a stimulus that will result in the devising of a test or tests that foundrymen and consumers can agree on as both adequate and simple.

J. N. CHESTER:[3] The paper of Professor Talbot's leaves little to criticize, and much to commend. The report of the Committee on Standard Specifications[4] is to me, to a certain extent, disappointing, at least as regards the progress that has been made or has not been made. Notwithstanding the progress that has been made, there seems to me to be considerable that might be, and that Committee ought to have regard for some of us that are growing old and are still curious. I am one of the Twentieth Century members, having attended my first meeting in 1894, and I have attended few annual meetings where the subject of cast iron pipe specifications has not been discussed. I can plainly state that the specifications under which we now work bear too heavily the footprints of the manufacturer, and therefore I would like to see at least a partial revision of those specifications, even though we are having some wondrous data as a background for progress reports. I do not mind mentioning some things that I think ought to be incorporated in an immediate change. For instance,—I would make only one grade of 4-inch pipe, or persuade manufacturers not to make it at all. I would limit 6-inch pipe to two grades or classes A and B, 8- and 10-inch to three classes A, B and C, and 12-inch and above that to four.

Having heard internal rather than external diameter reduction variations discussed, I want to register hard against that. I know it would lessen the cost of manufacture if the flask that governs the outside diameter could always be the same, but I believe the benefit of knowing the capacity of your pipe is worth what it costs the water works consumer.

I want also to urge action on interior coatings and the early adop-

[3] Consulting Engineer, Pittsburgh, Pa.

[4] This Journal, page 794.

tion of something. I should like at once the incorporation of a provision that 12-inch and above specials must be tested, if required.

I have never risen to the height of considering external earth pressure for ordinary depth, which we will say now all over the country is not governed as much by frost as by getting away from the effect of automobile trucks; and finally, I should like to see longer than 12-foot standards adopted for 4-, 6- and 8-inch pipe.

CHARLES W. SHERMAN:[5] Mr. Chester says he wants the actual inside diameter to correspond to the nominal figure so that we will know something about the capacity of the pipe. Perhaps when the pipe is new we may know something about it, but after two or three years we have got to make tests, if we are going to have any good line on how much a pipe will carry. I have had occasion to make quite a number of tests in the last two or three years, on pipes carrying soft waters, and I found 6- and 8-inch pipe, twenty to twenty-five years old, showing a loss of carrying capacity running as high as 40 to 50 per cent. Such conditions may not exist with the harder waters of the west and south, but in our New England waters it is frequently the case. Even when pipe looks pretty clean, I would a good deal rather have a little additional diameter than not. If a 6-inch pipe measures $6\frac{1}{4}$ inches, it is worth something to us in carrying capacity and in keeping up the capacity.

I think a good many water works men are buying more cast iron than they need in their pipes; the thinner pipe has not been used as much as it might well be for suburban localities. I am not talking now about metropolitan cities. If I were laying pipes in New York City I should be strongly tempted to buy the heaviest pipe I could get, but for suburban locations where the loads that come on the pipe are not abnormally heavy, and where the streets are not filled up with pipes I think many of us could use thinner pipe than we have been in the habit of buying. So I have been strongly predisposed to the thinner pipe that we are getting by the new process. During the last three years I have used De Lavaud centrifugal pipe, and my experience so far has been all good. I do regret somewhat that we are still dependent entirely on the manufacturers' specifications in buying such pipe; I think the purchasers ought to have something to say about what they get. I admit, however, that I do not know

[5] Consulting Engineer, Boston, Mass.

enough about what we ought to get to draw specifications myself, and so I have got along with what I could get.

I was gratified to see, from Professor Talbot's figures, that the results really made a good showing for the chilled centrifugal cast pipe. It is to be expected that pipe cast by that method will be somewhat more brittle than pipe cast in sand molds. Possibly sufficient annealing might eliminate that, but how much annealing is practically possible, is one of the things about which the purchasers know little, if anything, as yet.

I have found that men using that pipe, after very little experience, learn how to cut it, how to handle it, and how much it will stand in the way of rough usage; and I do not find that as a rule they are appreciably more careful in handling it than they are with sand cast pipe.

W. W. BRUSH:[6] Professor Talbot has presented to water works men the first comparative data based on comprehensive tests that has been published since the centrifugal process of casting pipe was developed. It is to the advantage both of the industry and the consumers to secure from a given tonnage of cast iron the greatest number of pipe of a satisfactory quality and at the lowest cost for production. For some sixty years the standard process for manufacturing cast iron pipe has been the sand lined flask and center core. The advancement in the art during these sixty years has been by minor refinements. Recently we have had presented to us a new process which seems to be destined to replace the old process as the cost of production will be less and the product will be freer from imperfections.

The centrifugal process turns out an iron of much greater strength, but as yet the problem of relieving the internal cooling stresses which produce brittleness has not been satisfactorily solved in at least one of the methods of manufacture now in use.

The experience of those using cast iron pipe is of interest in passing on the product of the centrifugal process, but is not conclusive. With the very high factor of safety in all designs of cast iron pipe for water works there certainly should be no trouble in safely handling, laying and using the pipe.

The large factor of safety is a recognition of the relatively unre-

[6] Deputy Chief Engineer, Department Water Supply, Gas and Electricity, New York, N. Y.

liable strength of cast iron. Tests made by competent investigators such as Professor Talbot will properly be the means of enabling both the producer and the consumer to determine correctly what process is best suited to serve the community and to set up standards by which to measure the quality of the pipe offered by the manufacturer.

We will all await with interest further tests to supplement those already made by Professor Talbot and we congratulate him and his associates on the excellent work done and its full presentation which gives us material which will greatly aid all of us in the water works field and which will affect the cast iron pipe we will use in the future.

J. T. MacKenzie:[7] Professor Talbot certainly has rendered a great service in the investigation so ably reported in this paper. He has made a most representative selection from the pipe foundries of the country, and by the completeness of his tests has definitely established a standard of comparison for all new products which have, or may, come into the field.

He is also to be congratulated on the excellent test strips proposed which it appears are destined to fill a long felt want in a most efficient and acceptable manner. Many have made use of strips, but it remained for Professor Talbot to suggest a practical way in which they could be used.

In discussing a mass of data of this kind it is essential to tabulate the results on some common basis so the mind can readily grasp the outstanding features. Such a tabulation is shown in table 1, where the material is arranged according to the several classes of pipe and the results are reduced to a unit basis throughout.

The first group consists of the standard product of the present pipe foundries, i.e., pipe cast vertically in dry sand molds with dry sand cores. The pipes selected for this test are fully representative of present practice, and are in accordance with present standards, being from Alabama, Virginia, Ohio and New Jersey.

This group represents the material that has established cast iron pipe as the universal standard for water and gas works construction, and which has justified the slogan, "Service for Centuries," both by its strength, its resilience and its resistance to corrosion.

The second group consists of pipe cast centrifugally in green sand

[7] Metallurgist, American Cast Iron Pipe Co., Birmingham, Ala.

TABLE 1

Summary of Talbot tests on cast iron pipe

LOT NUMBER	BURSTING TESTS		DROP TEST	FLEXURE TESTS			STRIP TESTS	
	Tensile strength	Mean deviation		Modulus rupture	Mean deviation	Modulus elasticity	Modulus rupture	Modulus elasticity
	I	II	III	IV	V	VI	VII	VIII
Group I. Regular sand cast								
1	13.9	4.8	16.7	29.0	3.8	10.15	35.3	7.50
4	16.1	10.3	16.6	32.2	6.4	9.40	38.3	7.20
20	14.7	9.2	14.0	27.0	2.2	10.03	33.9	7.71
30	13.7	2.6	15.3	26.8	0.7	9.13	33.7	6.63
40	13.4	15.6	20.3	29.3	7.1	10.20	39.1	7.43
70	14.8	3.9	14.4	28.4	5.3	10.07	35.0	7.16
71	14.6	9.3	16.0	26.3	2.7	9.60	29.3	6.87
72	14.4	3.7	18.2	26.9	6.5	9.03	32.3	6.61
73	16.4	7.3	14.2	26.9	4.9	10.24	35.5	7.32
Average.....	14.7	7.4	16.2	28.1	4.4	9.84	34.7	7.16
Full resilience.....					9.5		20.7	
Group II. Centrifugal refractory mold								
A	20.2	1.9	16.4	39.5	2.4	9.75	43.5	7.53
B	20.8	6.5	19.0	30.7	3.5	10.52	41.1	7.95
F	19.6	3.5	16.1	37.5	4.4	10.42	43.0	8.25
75	20.6	5.7	18.1	38.6	8.5	9.92	46.0	7.67
Average.....	20.3	4.4	17.4	36.6	4.7	10.15	43.4	7.85
Full resilience.....					15.8		31.6	
Group III. Centrifugal metal mold								
50	15.7	7.5	14.6	34.5	5.8	14.78	50.8	11.22
51	24.4	12.3	12.6	32.2	6.5	15.08	43.5	11.86
52	25.8	5.6	14.2	37.0	12.2	14.86	48.8	11.17
74	30.0	3.8	11.6	42.7	4.3	14.67	50.7	11.05
Average.....	24.0	7.3	13.2	36.6	7.2	14.85	48.5	11.32
Full resilience.....					9.8		25.0	
Group IV. Sand cast horizontally								
60	15.6	19.3	13.1	33.1	8.1	10.63	40.0	7.34
76	20.9	10.6	16.4	36.1	4.7	10.26	43.7	7.56
Average.....	18.2	15.0	14.8	34.6	6.4	10.45	41.9	7.45
Full resilience.....					13.7		30.6	

molds. This product does not depart from the accepted standards for cast iron pipe, either in contour or in metal structure, though the process sets new standards of excellence in uniformity of section and soundness of metal.

The third group consists of pipe cast centrifugally in water cooled metal molds, which process requires that the pipe be annealed to relieve casting strains and soften the hard, brittle exterior of the pipe as cast. This product is essentially different in metal structure from the standard product, and it is not made with a bead on it, but the metal thicknesses are well controlled.

The fourth group is cast horizontally in green sand molds with green sand cores. It has a true grey iron structure, but the method of casting renders it difficult to keep it free from inclusions, and to produce uniform results.

Column I shows the tensile strength of the pipe wall in thousands of pounds per square inch, calculated from the bursting pressure. These figures are low for anyone accustomed to vicarious test pieces, but they are easily understood when it is realized that the water pressure is applied to every point of the pipe wall. These results are not the results of the accidents of selection of test pieces, but are invariably the measure of the weakest place of the structure and as such are truly indicative of the ability of the several products to withstand static pressure in the line, although they do not indicate ability to function under other stresses, such as bending or shock which stresses are of prime importance.

Mean deviations are shown in column II.

Column III shows the results of the impact test, calculated in feet of drop per inch of wall thickness. This test was designed to show the relative ability of the several groups to stand the blows of loading, shipping and laying; and it is, at least, some measure of the ability to withstand water hammer.

Columns IV, V, and VI show the results of the cross-bending tests on the full length pipe tested as a beam. The modulus of rupture, column IV, is given in thousands of pounds per square inch. The deviations, column VI, are in percentage. The modulus of elasticity, column VI, is in millions of pounds per square inch. This test shows the value of the pipe in case of ground movement, or any other bending stresses. The values for modulus of elasticity show inversely the bending qualities, that is, the lower the value of modulus of elasticity, the more the pipe will bend. Ability to bend is a far better

quality in a pipe than ability to resist bending, as in many cases the force is practically irresistible for short distances, and the only hope for the pipe is for it to yield. Tensile strength, as indicated by the modulus of rupture, is desirable if flexibility is not sacrificed in its attainment, but, of the two, flexibility is of much greater importance.

Columns VII and VIII show the modulus of rupture and of elasticity, calculated from the strip test as described by Professor Talbot but placed by him in separate tables. Our purpose in assembling these data anew is to consider them collectively in their relation to the quality of the pipe as shown by the three principal tests.

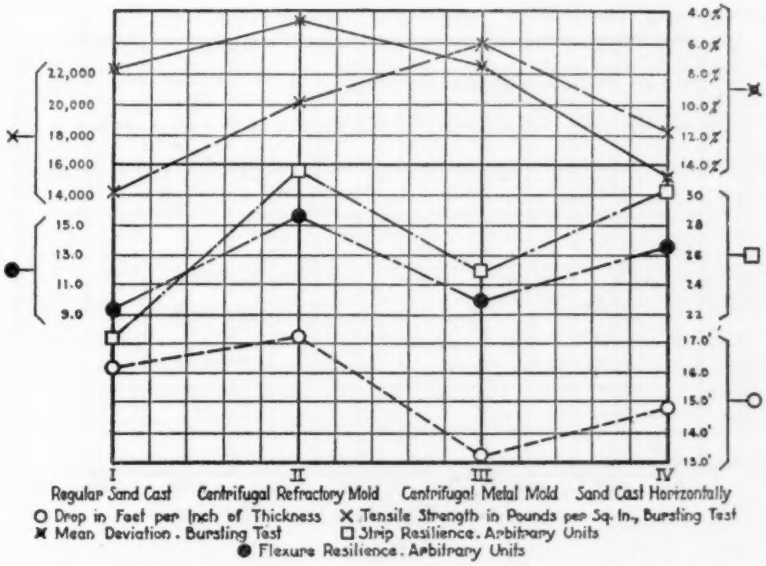

FIG. 1. GRAPHICAL REPRESENTATION OF TALBOT TESTS OF CAST IRON PIPE

Just as elongation and reduction of area are given equal importance with tensile strength in considering the value of steel for structural use, the deflection of cast iron is considered of equal importance with the strength in tests of this material. With the different wall thicknesses involved the only way to express unit deflection is by means of Young's modulus of elasticity which is, as Professor Talbot says, not an absolute but a relative quantity. The resilience, or capacity of a beam for storing energy, is, for a standard beam, the area below the load deflection curve, and if this were a straight line the resilience

would be the product of the load and the deflection. A linearly relative quantity in this case is the square of the modulus of rupture divided by the modulus of elasticity, and since the span lengths are the same for all groups this quotient gives an exact comparison of the work done in breaking the several specimens, when modified by the percentages given in Professor Talbot's discussion of resilience, which correct for the difference in curvature. In table 1 this value is placed below the averages for each group, and in figure 1 these results are shown graphically with the results for the drop test, calculated to feet per inch of thickness by the formula $H = \frac{h}{t^2}$, the

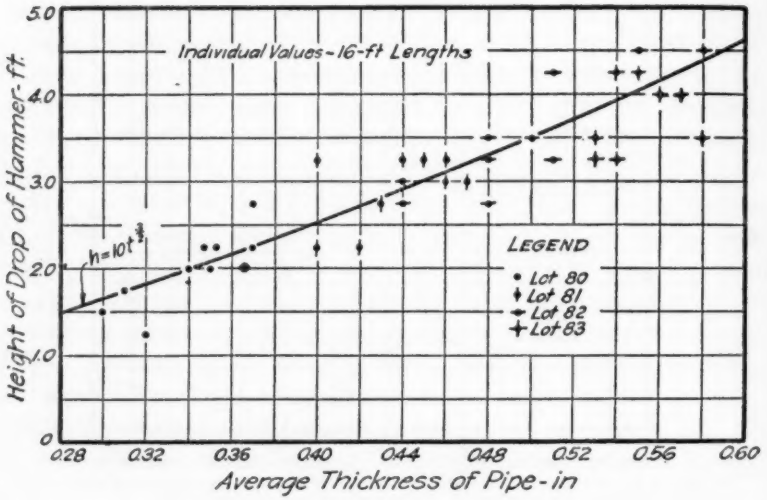

FIG. 2

tensile strength from the bursting pressure, and the mean deviation in bursting strength for each group.

The agreement of the resilience curves on the strip and flexure tests is remarkable, and the drop test shows the same general relations for the several groups.

In closing, it is suggested that one reason for the discrepancy between the various tests on lot 50 is that the average thickness of the pipe tested in flexure, which were also used for the strips, was 0.35, but the average in the bursting tests was only 0.306 inch. The pipes tested by the drop were also 0.35 inch in thickness.

ARTHUR N. TALBOT.[8] The results of tests made after the impact testing machine had been modified so that the distance between centers of supports for the pipe became 2 feet instead of 10 feet seem to warrant publication. The new arrangement of the testing machine permitted making tests at various places along the length of a pipe, and tests were made on the same pipe near the bell end, the spigot end, and the middle of the length. In figure 2 are plotted the thickness of pipe at the section tested and the height of drop at failure for four lots of pipe made in 16-foot lengths by the centrifugal process

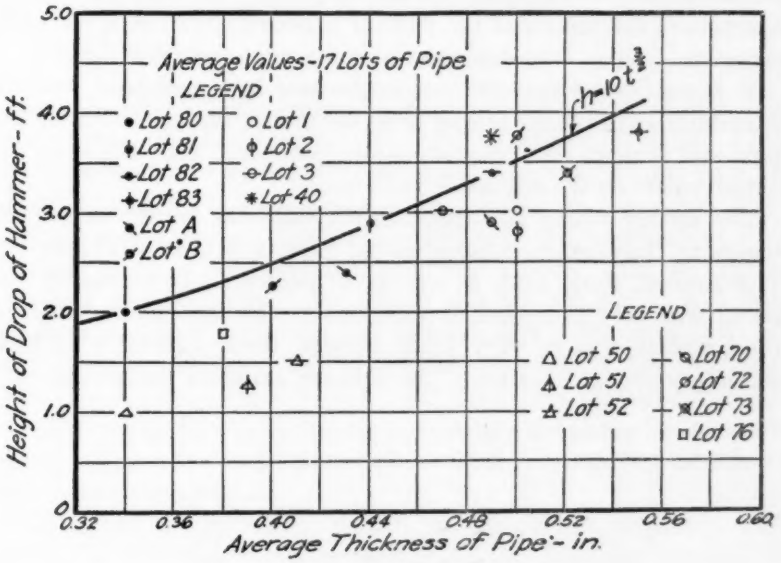

FIG. 3

(sand mold) used for making the pipes of Groups II and VI. In general, the pipe in these lots varied from thin pipe in Lot 80 to greater thickness in Lots 81 and 82 and a still greater thickness in Lot 83. Three pipes of each lot were tested, each pipe at middle, bell end, and spigot end, making 36 tests in all. The individual results of the tests are plotted in figure 2. There is little scattering of the points, considering that the figure is a plot of individual results. There is no marked difference apparent in the relation between thick-

[8] Professor, Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.

ness of pipe at the section tested and height of drop, whether the test is made at middle, bell end, or spigot end. The curve shown on the figure, $h = 10t_2^3$, represents the results fairly well, h being the height of drop in feet and t the average thickness of the pipe wall in inches at the section of the test.

In figure 3 are plotted the results of tests made on the remaining available pipes of the 13 lots named in the legend, together with those of the four lots already shown in figure 2. In lots 70, 72, 73, and 76 only a single pipe was tested; in lots 40, 50, and A two; and in the remaining lots three pipes. In all cases the points plotted are the averages of the results of the tests at middle and two ends for each given lot of pipe. The curve shown is the same as that in figure 2.

It is considered that the test in the new form avoids or reduces uncertainties in results arising from the inertia and deflection of the pipe and is more distinctly an impact test, and thus that it is an improvement on the original form of test.

The author wishes to substitute the following for the statement regarding the characteristics of metal in pipes in Group III given in The Journal, July, 1926, at the top of page 42: "In Group III the metal was very fine grained throughout. At the exterior surface the graphite was in very finely divided form—almost wholly of secondary origin. Inwardly the primary graphite predominated."

ALGAE TREATMENT OF RESERVOIRS, RECENT EXPERIENCE[1]

By Frank E. Hale[2]

Out of the year's experiences with New York City water supplies, three may be mentioned as of general interest.

JEROME PARK RESERVOIR

On August 25, 1925, Jerome Park reservoir was treated with copper sulphate for Asterionella, 1500 units, dosage 0.18 p.p.m. Contrary to usual practice the reservoir was not turned into service again until September 8, two weeks later. Within a few hours some three hundred complaints were received over the telephone of foul-tasting water. The reservoir was immediately shut off again. Samples examined from top, middle and bottom depths indicated that the decaying organisms had concentrated in the bottom water, and as draft was from the bottom the full effect of the treatment was experienced. Usually taste and odor from treatment disappear in two to three days and experience like the above has not been noted. The complaints were well justified judging from certain of the samples received.

Meantime a secondary growth of Dinobryon occurred, 1550 units, the protozoa probably feeding on the decaying Asterionella or on the bacteria which rapidly increase following the killing of microscopic organisms, since the Dinobryon predominated at the bottom. A second treatment was given on September 14 of the same dosage and it is interesting to note that, although, as usual, the surface water was treated, the organisms which were at the bottom were entirely destroyed. The depth of the reservoir is about 25 feet. Great care was exercised in turning the water on again. Samples from top, middle and bottom were again examined and the reservoir turned into service gradually from mid-depth, beginning on the 19th. By the 24th it was about one-half in service,

[1] Presented before the Buffalo Convention, June 11, 1926.

[2] Director of Laboratories, Mt. Prospect Laboratory, Brooklyn, N. Y.

all that could be taken from mid-depth. Bottom draft was then commenced and increased until the reservoir was entirely in service. Observations of taste were made frequently at the reservoir as it was turned gradually into service, both of the effluent and of the bypassed water. As a result of this experience, a new procedure

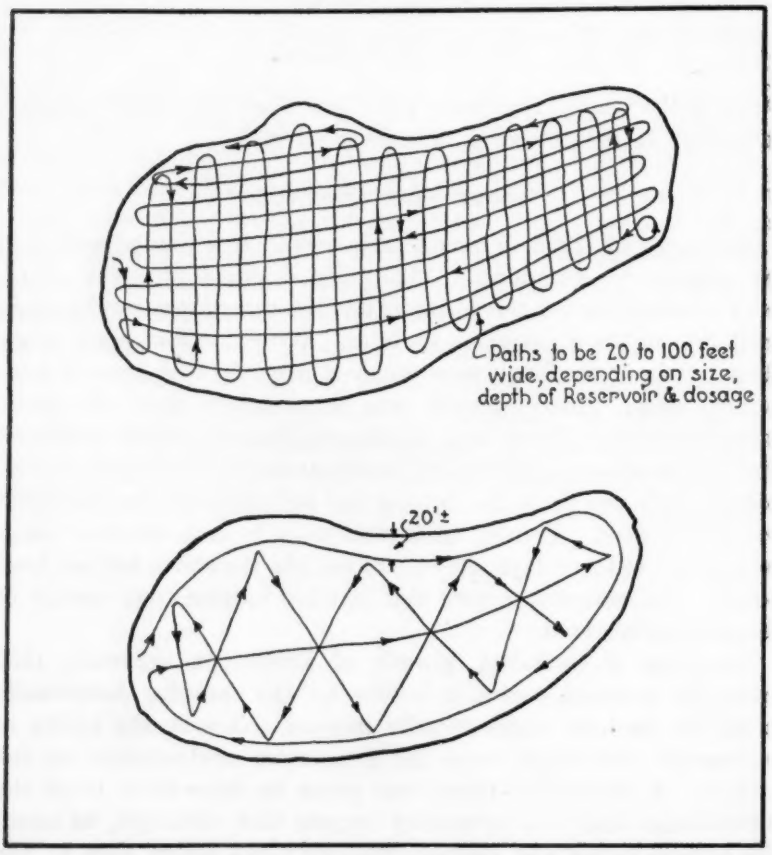

FIG. 1. METHOD OF APPLYING COPPER SULPHATE TO LARGE AND SMALL RESERVOIRS

for treatment and putting into service of reservoirs was outlined and distributed. The main points of this procedure are:

Care in distributing the copper sulphate rapidly and uniformly. Figure 1 shows the course of the boats for large and for small reservoirs. On large reservoirs the courses are parallel in one direction

and then parallel in a direction at right angles to the first. On small reservoirs the courses triangulate the surface.

Prompt inspection, if possible the third day after the treatment, should be made, noting local conditions such as odor arising from the surface of the water, particularly to leeward of any wind, and physical appearance of the water. Laboratory examination of samples should note whether organisms are dead, in process of decomposition, or mere shells, particularly noting the appearance of coloring matter, whether faded or jumbled in appearance, also the promptness with which organisms settle in the bottles on standing.

Wherever possible, when turning a reservoir into service again the flow should be established gradually mixing effluent water with bypassed water and noting turbidity, taste and odor of both effluent and mixed flow. If required, this process may take several days.

Every effort should be made to prevent stirring up deposits either in reservoirs or in conduits which have been idle or full of stagnant water.

If possible, avoid drawing water from the extreme bottom of a reservoir following treatment. Mid-depth or at least ten feet above the bottom is preferable. Surface draft may sometimes be advisable, but should not be continued, in order to avoid stagnation effects in the reservoir.

CENTRAL PARK RESERVOIR

On April 19, 1926, the influent half of Central Park reservoir was treated with copper sulphate for 1150 units of Asterionella, dosage 0.25 p.p.m. The interesting part of this treatment is that the reservoir was kept in service during treatment. It is oval-shaped and water enters at one end and leaves at the other. At present rate of draft the water of the lower half of the reservoir would be displaced in ten days, hence the treated half could not reach the consumer until free from taste and odor due to treatment. The results of microscopical examinations of the effluent were as follows:

	ASTERIONELLA	TOTAL ORGANISMS
April 15	1,150	2,040
April 22	1,350	2,100
April 29	370	500

A variety of organisms was present, such as Melosira, Synedra, Aphanizomenon, in addition to the Asterionella, which were also greatly reduced. Similar treatments in recent years have been successfully given for 10,000 units of Synedra, dosage 0.36 p.p.m. (3 pounds per million gallons), and for 4000 units of Dinobryon, dosage 0.20 p.p.m.

CROTON WATERSHED

Recently Synura has been heavily prevalent in the Croton watershed. A few units have been present daily in the Croton aqueduct water for several weeks, on April 22 to May 8, 3 or 4 units per cubic centimeter, and May 8 to May 15, 1 unit. Chlorination, 0.54 p.p.m., has taken care of the aqueduct water, but extensive treatment of the watershed reservoirs with copper sulphate was carried out. Continuous treatments by suspended bags were temporarily made of Sodom reservoir effluent and at Muscoot Dam, April 20 to 26. The following table gives the data of these treatments:

DATE	LOCATION	COPPER SULPHATE DOSE		SYNURA
		pounds	*pound per mil. gal.*	*units per cc.*
Continuous April 20–26	Sodom effluent and Muscoot Dam	1,800	1	100
May 3–7	Bog Brook reservoir	4,500	1	325
April 23–24	Sodom reservoir	7,650	1½	1,300
April 26	Diverting Basin	900	1½	250
April 26–29	Muscoot reservoir	7,200	1½	125
April 26–30	Croton Lake (Muscoot Dam to Old Dam)	8,550	1	150
Total.....		30,600		

Five boats were used, including one launch. The Synura was entirely destroyed. Dosage was figured on total volume of water at time of treatment. This treatment is interesting on account of its extensiveness. Similar treatment was carried out in 1923 for Aphanizomenon, dosage 1 pound per million gallons. It recalls also the complete treatment of Kensico reservoir in the winter of 1923 (December 8–30) with 20 tons of copper sulphate for Synura, dosage 1 pound per million gallons.

LINING AND COVERING OF THE HIGH SERVICE RESERVOIR AT QUINCY ILLINOIS[1]

By Paul Hansen[2]

The City of Quincy has, during the past year, provided a concrete lining and cover for an equalizing reservoir on the distribution system having a capacity of approximately 20 million gallons. The undertaking is of interest on account of its magnitude, certain features of design, the rapidity and system with which it was built, and on account of the proposed use of the top for tennis courts. It is also interesting to note that, although the reservoir is exceptionally large, as compared with the quantity of water pumped daily, namely about 5 million gallons, the City considered this volume of elevated storage of sufficient value to fully warrant the expenditure of placing it under cover.

A very brief description of the existing water works will make clearer the relation of the equalizing reservoir to the rest of the water works.

The supply is taken from the Mississippi River through an intake as remote from local pollution as possible. The water is pumped by means of low lift, electrically driven centrifugal pumps to a filter plant having a nominal capacity of 6 million gallons per twenty-four hours. The water from the filter plant enters a clear water reservoir under the filters with a capacity of about 100,000 gallons and this storage in turn is supplemented at the same elevation by a recently constructed circular concrete reservoir of about three-quarters of a million gallons capacity. The water from these reservoirs is lifted by two electrically driven centrifugal pumps into the distribution system. The excess of pumpage over consumption enters the large equalizing reservoir and becomes available when consumption is in excess of pumpage. At normal rates of consumption the equalizing reservoir has a supply that will last the city approximately four days. Near the equalizing reservoir is a small section of the city that can

[1] Presented before the Illinois Section meeting, March 24, 1925.

[2] Pearse, Greeley and Hansen, Engineers, Chicago.

not be served by gravity from the reservoir. This section is served by a high service distribution system supplied by a small electrically equipped pumping station taking water from the mains near the large reservoir. An elevated tank of about 300,000 gallons capacity adjoining the pumping station serves to equalize pressure on the high service distribution system.

The large equalizing reservoir has a capacity sufficient to meet any reasonable fire emergency without assistance from the pumps. It also has a capacity to tide over any break-down of the pumps likely to occur. It is not necessary to maintain standby equipment, although the old steam pumping equipment and boilers are still available for standby service. It is not the practice, however, to maintain fires under the boilers.

The availability of the equalizing reservoir permits the city to obtain favorable power rates for all pumping can be done by a single pump operating at a uniform rate and on an off-peak load. The current is obtained from the hydro-electric development at Keokuk.

The original equalizing reservoir was constructed in 1881–82 and consisted of an open basin 424 feet long by 328 feet wide at top of inside slopes of embankments and about 25 feet deep, the embankments having slopes, both inside and outside, of two on one. The embankments were made of materials excavated within the reservoir. The outside slopes were sodded and the inside slopes were paved with limestone placed on 9 inches of clay puddle. The bottom was covered with about 12 inches of clay puddle.

Trouble developed on account of algae growths in the clear filtered water that was delivered to the reservoir. To overcome this the reservoir was covered in 1898 with a roof of white pine supported on 6 inch x 6 inch x 12 foot posts, the posts in turn being supported on short brick piers. All posts were given two coats of preservatives. This covering deteriorated and had to be removed in 1905 or seven years after it was built.

The practice of treating the water with copper sulphate was started in 1907 and continued until the reservoir was put out of service in June 1925 to permit the new construction. Copper sulphate did not, however, prove completely effective in keeping down the algal growths, and, moreover, there was the danger of miscellaneous contamination that might be thrown into the reservoir by mischievous or careless people. In the latter part of 1924 a complete concrete

cover and lining was authorized by a large favorable popular vote on a bond issue which bond issue was predicated on plans prepared by Pearse, Greeley and Hansen. Bids were taken for the work on May

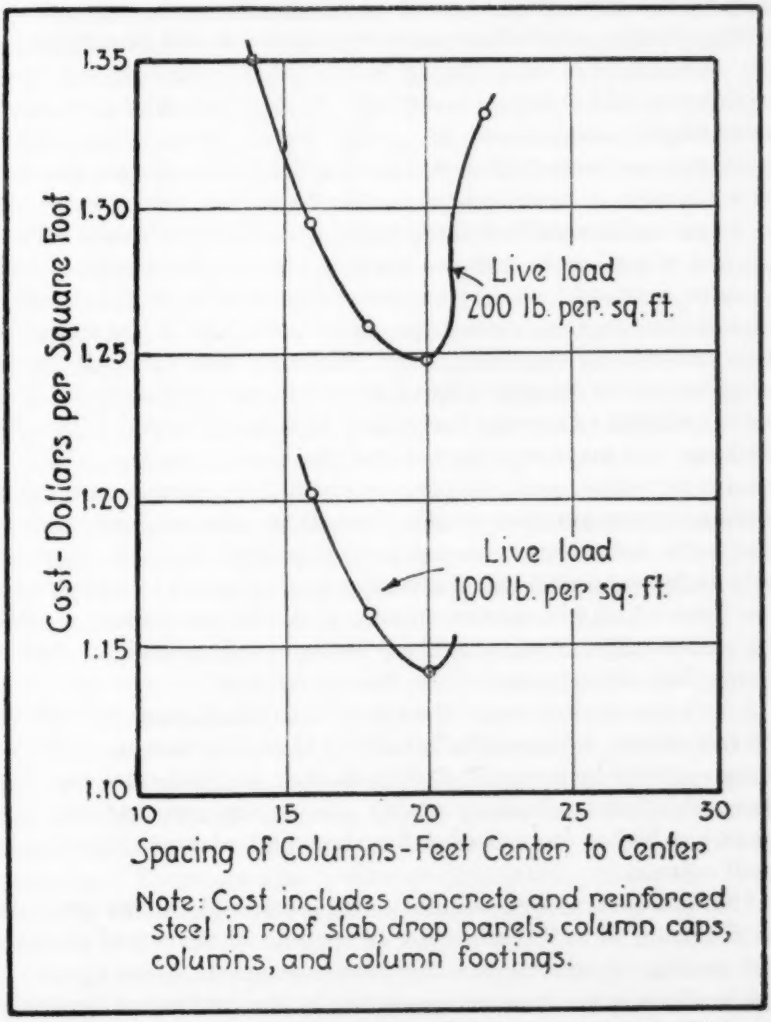

FIG. 1. WATER RESERVOIR—TOTAL COST PER SQUARE FOOT FOR VARIOUS COLUMN SPACINGS

28, 1925 and the contract was awarded to the Priester Construction Co., of Davenport, Iowa, at an estimated cost of $174,578. Sixteen contractors in all submitted bids for this work.

In designing the new construction, special effort was made to have as many repeated details as possible so as to permit the maximum re-use of forms. Care was also taken to have the design such as to simplify the form work as much as practicable.

The question of absolute water tightness was not important for the embankments had, during many years, demonstrated their capacity to hold water. Accordingly the floor and sides were made up of 6-inch paving placed in a single layer. In providing expansion joints an arrangement was used which would permit the column footings to move independently of the floor paving inasmuch as it was anticipated that there might be a slight difference in the amount of settlement between the columns and the paving. This actually developed to be the case. The roof is of the flat slab type of construction. It is typical of construction of this character and involves no especially novel features. The roof was made strong enough to support a live load of 200 pounds per square foot which included an average covering of 12 inches of earth. The slab thickness was made eight inches and the design was based on 650 pounds per square inch compressive strength in concrete and 16,000 pounds per square inch tensile strength in the reinforcing steel. The earth covering was used in part to protect the roof structure from undue expansion and contraction and to provide a better surface upon which to construct tennis courts. It also makes possible the growth of grass and shrubbery between and around the tennis courts, thus adding materially to the appearance.

A curb was needed around the top of the embankment to support the roof slabs. Advantage was taken of this to increase the capacity of the reservoir by some 2,000,000 gallons, making the total capacity about 20,000,000 gallons by merely making the curb and columns somewhat higher than needed for structural reasons at relatively small expense.

Alternate designs were studied using a series of column spacings varying from 14 to 22 feet center to center. It developed that 20-foot spacing of columns was the most economical. (See figure 1.)

A problem in drainage was presented by the covering of the reservoir. The original embankments are of a clayey material which has a tendency to slough when saturated with water. Prior to the placing of the covering on the reservoir so little water reached the outside slopes from rainfall on the top and slopes of the embankment that it

rarely became saturated enough to have any tendency to slough. With the new covering in place, however, large quantities of rain falling on the covering must be taken care of, so it will not flow over the embankments and erode them or saturate them and cause them to slough. Such sloughing actually occurred during the progress of construction, illustrating the new danger to the embankments. To overcome this danger, a gutter was placed around the entire periphery of the top of the reservoir and so arranged as to convey storm water to several points where it may be safely lead to street gutters or storm sewers by means of pipes.

The inlet and outlet arrangements are so designed as to provide a good circulation of water in the reservoir. There is only one connection to the mains. From this there was laid a header pipe on the floor of the reservoir and extending to the opposite end. At intervals of 120 feet there are three lines of smaller pipe extending to points near the sides of the reservoir and at right angles to the main header. The ends of the laterals are provided with check valves. On one side of the reservoir the check valves open outward and on the other side they open inward. Therefore the entering water will be admitted to one side of the reservoir and withdrawn from the other. The main header and laterals are so proportioned in size as to create approximately the same friction losses to each of the inlet check valves and each of the outlet check valves.

Inside the reservoir are placed pressure pipes furnished with water from the high level distribution system of the city for the purpose of cleaning the inside of the reservoir.

Ventilation is furnished within the reservoir by two ventilating houses, one at either end of the reservoir. One of the houses also provides means of access to the reservoir. They have been given architectural treatment which renders them pleasing in appearance. There are also a number of manholes in the top of the reservoir which will admit light and air and provide access at any time that the reservoir may be emptied for repairs or cleaning. These manholes are provided with lock down covers so that they cannot be opened by unauthorized persons and they are so designed that surface drainage cannot enter.

Some consideration was given in the design of the reservoir to the installation of a division wall which would create two independent basins, but the rather large expense involved for such a division wall

was not deemed warranted under local conditions. In the first place, the reservoir will hold clear water only, so that it will have to be emptied for cleansing purposes at very rare intervals. It is also quite improbable that any break will occur which will require the emptying of the reservoir for repair purposes. Even if this should be the case, it is always possible to start up the steam pumping equipment to keep the city in an adequate supply of water when the reservoir is emptied.

The contractors began work on June 8 and completed the contract 32.3 days in advance of the time allowed for the completion of the work and thus became entitled to a bonus of $3230, or at the rate of $100 per day. The work of the contractors was very carefully planned and with very few exceptions was carried out very closely on schedule. Practically the only exception was caused by some delays in the delivery of reinforcing steel for the roof and by weather conditions.

In arranging their plant, the contractors took advantage of the existing reservoir embankment. Sand and gravel bins were erected on the outside of the east embankment of the reservoir and a truck ramp was built on the embankment so that the trucks carrying materials could drive directly to the top of the embankment and dump sand and gravel into bins. From the bins the sand and gravel was permitted to flow by gravity through suitable gates into batch measuring cars. These cars operated on an inclined railway to a point above the level of the concrete mixers located at the top of the embankment. The cement was stored in a building at the base of the embankment along side the railway for the batch cars and was handled by hand into the batch cars. This constituted practically the entire hand handling of materials about the contractors' plant. The finished concrete was dumped into elevators which carried the concrete to a tower 140 feet high equipped with an Insley spouting system. The spouts discharged into hopper shaped receivers as close to points where concrete was being placed as practicable. The receivers in turn discharged into concrete buggies which were pushed by hand to wherever concreting was being done. The receivers served to re-mix the concrete after its passage down the chutes thus preventing segregation of materials in the concrete as placed.

The work of building the reservoir proceeded generally in the following manner. Column footings were poured first, then a section

of side slope or floor around these footings were poured. Next the columns were poured and finally the roof slab. The work was so planned that it proceeded from the east side of the reservoir to the west side, keeping the footings and floor columns enough in advance of the roof slab so that carpenters could be kept busy on shoring and forms for the roof continuously. The earth removed from the bottom of the reservoir was placed in a pile on the west side of the bottom area and stored there until the roof was sufficiently seasoned to permit

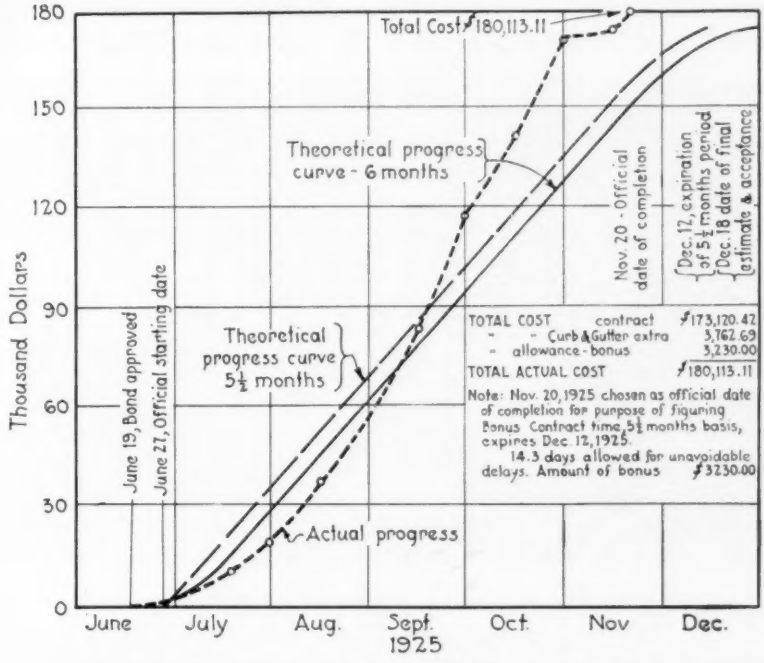

FIG. 2. HIGH SERVICE RESERVOIR—PROGRESS CHART

spreading it thereon. In this way a minimum handling of earth resulted.

The roof slab and drop panels at column heads were supported by 4 inch x 4 inch shores and 2 inch x 6 inch stringers. The stringers rested on steel clamps bolted to the shores. These clamps were made of short pieces of angle iron containing a curved slotted hole. They were bolted at the correct height with the bolt in the bottom of the curved slot. When ready to remove panel forms, the bolt was loosened and the clamp allowed to drop about $1\frac{1}{2}$ inches. This

allowed the stringers and panels to be readily removed and carried ahead. It also prevented injury to the forms on account of nails. Where nails were required to support the cross bracing for the shoring a special type of nail with a collar was used so that it could not be driven flush. Thus it was possible to remove the nails readily and with minimum damage to the lumber. Forms were removed from beneath the roof slab in ten days, but the shoring remained in place for twenty-one days after the concrete was poured. Concrete was 1:2:4 mix to which 5 pounds of lime were added for each bag of cement. All construction joints in the roof slab were made in the

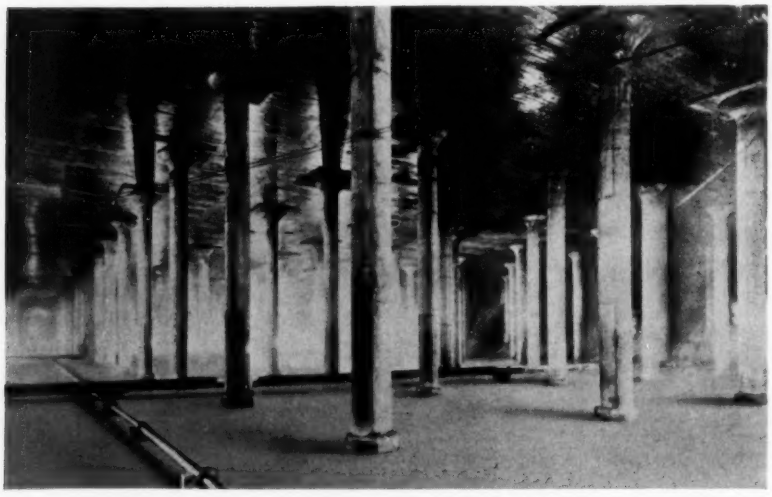

FIG. 3. GENERAL VIEW OF RESERVOIR

centers of panels. The reinforcing steel came on the work cut to lengths and bent as required.

As the work consisted largely of repetition of operations, the men became very expert in placing forms, pouring concrete, removing forms, etc., and progress was rapid and satisfactory. Figure 2 is a chart showing the progress rate on the work as compared with the theoretical progress curve on a five and one-half and six months basis. The curve of actual progress shows how the rate of progress accelerated during the first months. At the end is noted the inevitable slowing down incident to the final adjustment of details common on all construction work.

W. R. Gelston, Superintendent of Water Works, was of very

great assistance throughout the work and offered many valuable suggestions with reference to both design and construction. Preparation of detail designs for this work were under the immediate direction of R. S. Rankin. General supervision over construction was under the direction of J. K. Giesey. J. R. Longley was temporary resident engineer from June 18 to June 27. Mr. Longley was succeeded by W. A. Turner who remained as resident engineer from June 27 to October 18. Mr. Turner in turn was replaced by K. V. Hill who supervised the work to completion. The contract as noted was handled by the Priester Construction Co., with J. C. Tunicliffe in direct charge.

COMPARATIVE STUDIES OF STANDARD METHODS AND THE BRILLIANT GREEN BILE MEDIUM ON LAKE MICHIGAN WATER AT CHICAGO[1]

By C. C. Ruchhoft[2]

Several series of tests have been made in the laboratories of the Sanitary District of Chicago, to determine the feasibility of using the brilliant green lactose peptone bile medium in the determination of Bacterium coli. The tests have been carried on since September, 1924, and are still being continued. Six series of tests on a total of 1166 samples have been completed at this time. The tests were made on raw and chlorinated tap water from Lake Michigan. In two of the series of tests parallel plantings were made into lactose broth and brilliant green bile medium; while in all the other tests the brilliant green bile was used as a confirmatory medium. H. E. Jordan suggested the preliminary enrichment in lactose broth using the brilliant green bile as a confirmatory medium.

Series B was made in coöperation with Committee No. 1 of The Association.

Table 1 shows the procedure that was used to compare with the standard method as well as the source of the samples used in the different series. The raw water samples used in Series A to D were all collected from the Chicago pumping station tunnels. This water is not badly polluted, which makes it necessary to plant 5–10 cc. portions. The Chicago lake front samples used in Series E and F are more polluted and require the planting of single portions of from 0.001 cc. up to 10 cc. The tap sampling points at the Chicago suburban towns were selected for the tests because a larger number of positive presumptive tests are obtained at these points than at the Chicago city taps.

All of the lactose broth and endo agar was prepared according to the A. P. H. A. standard methods. Double strength lactose broth was used for planting all of the 10 cc. portions. In Series A dehydrated

[1] Presented before the Illinois Section meeting, March 25, 1926.

[2] Bacteriologist, Sanitary District of Chicago, Ill.

TABLE 1

Data on brilliant green bile tests

TABLE I

Data on brilliant green bile tests

	SERIES A	SERIES B	SERIES C	SERIES D	SERIES E	SERIES F
	September 9 to October 9, 1924	January 6 to February 18, 1925	March 3 to June 8, 1925	March 3 to June 8, 1925	December 2, 1925 to February 3, 1926	February 4 to February 27, 1926
Procedure compared to the Standard	Lactose Broth to B. G. B. to Endo to L. B.	Direct to B. G. B. to Endo to L. B. to agar slants	Same as B	L. B. to B. G. B.	L. B. to B. G. B. to L. B. to Endo to L. B.	L. B. to B. G. B. to Endo and E. M. B. to L. B.
Raw water samples from	68th Street P. S. R_1 Chicago Avenue P. S. shaft M. Lake View P. S. shaft 7	68th Street R_1 and R_2, Chicago Avenue R_3 and shaft M. Lake View shaft 7	Same as B	Same as B	Chicago Lake Front from Farwell Avenue to Calumet River	Same as E
Tap water samples from	Gary, Ind. East Chicago Hammond Lake Forest Waukegan Oak Park	Whiting Hammond Lake Forest Waukegan	Same as B	Same as B	None	None
Samples collected	Daily except Sunday	Monday Tuesday Wednesday	Same as B	Same as B	Daily except Sunday	Daily except Sunday
Number of raw samples examined	72	97	195	195	281	126
Number of tap-samples examined	166	76	153	153	None	None

lactose peptone bile obtained from the Digestive Ferments Company was used. Seventy grams of the dry product were dissolved in 1 liter of distilled water and a solution of brilliant green was added to give a concentration of one part of dye in 10,000 parts of the finished broth. The brilliant green used was obtained from Coleman and Bell, Norwood, Ohio, their lot No. 184. In the remainder of the work the green bile was prepared according to instructions furnished by McCrady and of materials recommended by him to make it comparable with the green bile broth used by The Association Committee.

DIRECT IMPLANTATION—PROCEDURE

The procedure in Series B and C was to make parallel plantings of 5 to 10 cc. portions of each sample into lactose broth and green bile broth. The standard procedure was followed to completion and spore examinations were made of smears stained by the Ziehl Nielson method from agar slants incubated seventy-two hours. The green bile broth tubes were incubated for seventy-two hours. All cultures showing positive gas were transferred to endo in twenty-four and forty-eight hours and all new positives and plus minuses were transferred after seventy-two hours. The endo cultures from the green bile were carried to complete confirmation the same as for the standard method.

PRELIMINARY ENRICHMENT—PROCEDURE

In the remainder of the work, where the green bile was used as a confirmatory medium all positives in lactose broth were transferred to the green bile broth at the same time that they were streaked on endo. In this case the green bile cultures were incubated for forty-eight hours and all positives and plus minus gas cultures were carried to partial confirmation, except in Series D where no green bile confirmations were made. In Series E and F, two methods of confirming the green bile positives were used. In Series E the green bile positives were transferred to an intermediate lactose broth tube at the same time they were streaked on endo. This intermediate broth tube was incubated for twenty-four hours at 37°C. and the culture was then streaked on endo and carried through in the regular way. This was done to determine whether some of the no growths obtained on endo were not due to the endo medium being

too inhibitory to some of the attenuated strains which grew slowly in green bile. The green bile positives in Series F were transferred to both endo and eosin-methylene blue agar plates and then back into lactose broth. This was to study any difference in the effect of endo agar and eosin-methylene blue agar on the cultures obtained from the green bile.

TABLE 2

Comparison of standard method with results of direct planting into the brilliant green bile medium

SERIES	WATER	STANDARD METHOD			MODIFIED METHOD			PER CENT OF LACTOSE BROTH PRESUMPTIVES CONFIRMED		PER CENT B. G. B. POSITIVES CONFIRMED
		Number of + presumptives	Number partially confirmed	Completely confirmed	B. G. B. positives	Number partially firmed	Number completely confirmed	Standard	Modified	
		(1)	(2)	(3)	(4)	(5)	(6)	(3)/(1)	(6)/(1)	(6)/(4)
B	Raw	89	72	68	52	44	43	76.3	48.4	82.6
C	Raw	327	150	130	128	65	65	39.8	19.9	50.8
B	Tap	83	51	50	36	35	35	60.3	42.2	97.2
C	Tap	169	73	55	27	18	17	32.5	10.3	74
B + C	Raw and Tap	668	346	303	243	162	160	45.3	23.9	65.8

RESULTS—DIRECT IMPLANTATION

The results of Series B and C are shown in table 2. The standard method gave 198 confirmations but only 108 were obtained from brilliant green bile. That is, 90 or 54.5 per cent of the standard method confirmations were lost in the green bile method. On tap water the confirmations obtained were 105 by the standard and 53 by the green bile. Again a loss of 52 or 49.5 per cent by the green bile method. While a total of 303 complete confirmations were obtained by the standard method only 243 green bile positives were obtained. These results show that the brilliant green bile medium

is entirely too inhibitory to some members of the colon group to be used as a direct medium for determining Bacterium coli.

It will be noticed from table 2 that the percentage of positive green bile cultures confirming is much higher than the percentage of lactose broth presumptives confirming by standard methods. This indicates that the green bile medium is more specific for the colon group than the standard lactose broth and for that reason it would be a desirable medium in making confirmations. The results on the endo agar also show that the green bile medium is more specific than lactose broth. These are shown in table 3. The Series C raw

TABLE 3

Results on endo agar and second lactose broth

WATER	METHOD	PER CENT OF ENDO PLATES			PER CENT OF 2ND BROTH TUBES
		Characteristic +	Non characteristic	No growth	+
Raw	Standard	80.2	12.2	7.6	86.6
Raw	Direct to green bile	92.2	5.8	2.0	86.2
Raw	Lactose broth to green bile	92.0	6.6	1.4	93.3
Tap	Standard	41.3	23.1	35.6	69.6
Tap	Direct to green bile	89.7	8.6	1.7	93.0
Tap	Lactose broth to green bile	88.1	9.5	2.4	61.7
Raw and Tap	All work from green bile	91.4	7.0	1.6	89.2

water endo results were not included as these were entirely out of line for some unknown reason. The highest percentage of non-characteristic and no growth plates was obtained by standard methods on tap water and the next highest by standard methods on raw water. The percentage of non-characteristic and no growth plates obtained from green bile broth used either for direct plantings or as a confirmatory medium on both raw and tap waters was very low. Of 741 endo plates obtained from the green bile broth there were only 7.0 per cent non-characteristic and 1.6 per cent no growth plates.

RESULTS—PRELIMINARY ENRICHMENT

The results of the Series A, D, E and F tests in which the green bile broth was used as a confirmatory medium are given in table 4. For raw waters the two methods are in excellent agreement in the percentage of presumptives confirmed, especially Series E and F. While it appears in the final results that the E and F series are almost perfect checks this is not actually the case. In looking over

TABLE 4

Comparison of standard method and modified method using brilliant green bile as a confirmatory medium

SERIES	WATER	STANDARD METHOD			MODIFIED METHOD		PER CENT OF + PRESUMPTIVES CONFIRMED		PER CENT OF + B. G. B. TUBES
		Number of + presumptives	Number partially confirmed	Number completely confirmed	B. G. B. positives	Number partially confirmed	Standard	Modified	Confirmed
		(1)	(2)	(3)	(4)	(5)	(3)/(1)	(5)/(1)	(5)/(4)
A.....	Raw	240	177	177*	205	171	74.0	71.0	83.5
D.....	Raw	327	150	130	139	139†	39.8	42.5	
E.....	Raw	291	241	235	239	232	80.7	79.7	97.0
F.....	Raw	128	107	101	103	101	78.8	78.8	98.2
Total.....	Raw	986	675	643	686	643	65.2	65.2	91.8
A.....	Tap	223	89		84	50	40.0	22.0	59.5
D.....	Tap	169	73	55	52		32.5	30.8	

* No spore examinations made.

† Green bile positives not confirmed.

the individual results it is found that occasionally a culture which confirms by the standard method does not confirm by the green bile method and vice versa. It is also found that occasionally a spore forming organism apparently grows in the green bile medium. In Series E and F it was found that four cultures which contained spores from the standard method had gone to partial confirmation through the green bile medium. These four cultures were transferred to the green bile broth the second time and one of them again

produced gas. Even with these slight discrepancies the green bile method to partial confirmation—i.e., lactose broth to green bile to endo to lactose broth,—checks wonderfully well with the complete standard test on raw water at Chicago.

SECONDARY ENRICHMENT

It was found that a small percentage of no growths on endo agar from the green bile could be saved by an intermediate planting into lactose broth. This was tried in Series E and while six no growths were recorded on the endo direct from the green bile, no cultures were lost when the green bile positives were cultured in lactose broth for twenty-four hours, before streaking on endo. This secondary enrichment adds twenty-four hours to the time required for the completed test, consequently it is undesirable and is not proposed as a routine procedure.

With regard to the special tests in Series F, it was found that the same number of green bile confirmations were obtained endo agar and eosin-methylene blue agar.

PRACTICAL VALUE OF GREEN BILE TEST

On raw water the partially confirmed test by the standard method checks well with the green bile positives. This is shown in table 4. There were 675 partially confirmed cultures by standard methods against 686 green bile positives, a difference of only 10 or 1.5 per cent. In Series E and F 84 per cent of all green bile positives were positive in twenty-four hours. Using this modified method, therefore, the partially confirmed test would be practically complete in three days while with the standard method five days are required. We have adopted this modified procedure at Chicago in our routine work on the lake front samples.

No definite conclusions can be reached from the results of Series A and D on tap samples shown in table 4. The results are rather meager, but it appears that the green bile broth is too inhibitory to the attenuated colon forms found in the Chicago district tap samples to be used even as a confirmatory medium. We are continuing our study of the green bile medium on the tap waters and hope to obtain more definite results in the future.

CONCLUSIONS

The conclusions reached from these experiments may be summarized as follows:

1. The brilliant green bile broth is too inhibitive to the Bacterium coli group for direct planting into the medium.

2. The green bile medium is much more specific than standard lactose broth and is desirable as a confirmatory medium.

3. Spore forming organism are practically all inhibited in the medium.

4. Preliminary enrichment in standard lactose broth for 48 hours and the transfer of all presumptive in brilliant green bile medium recording 10 per cent or more of gas in forty-eight hours as positive check remarkably well on raw waters with the standard method, carried as far as the second lactose broth tube. Final results are obtained in three or four days, instead of five or six.

5. With the above procedure partial confirmation of the green bile positives produces results comparable with the completely confirmed test of the standard method on raw water.

6. Further study of the medium is needed before its usefulness can be ascertained for use on chlorinated tap water.

PROGRESS REPORT OF COMMITTEE NO. 18 ON SAND TESTING AND RECORDING[1]

PURPOSE OF REPORT

The principal matter that has been brought to the attention of Committee No. 18 on Sand Testing and Recording of the American Water Works Association since the 1925 meeting in Louisville is a revised set of tentative specifications for sieves for testing purposes issued by the American Society for Testing Materials. The foreword attached to these specifications states that "this is a tentative standard only published for purposes of eliciting criticism and suggestions. It is not a standard of the Society and is subject to annual revision." It is the purpose of this progress report to discuss these tentative specifications and some related subjects suggested by them.

NEED AND CHARACTER OF STANDARD TESTING SIEVES

As will be observed from the last report of this committee (see p. 235, vol. 14 of THE JOURNAL) few persons take the trouble to calibrate sieves used for testing sand in accordance with the method established by Allen Hazen at the Lawrence Experimental Station of the Mass. State Board of Health in 1892, a method which has generally been regarded as constituting standard practice ever since, nor are they willing to pay the relatively nominal amount necessary to have sieves calibrated. The report also shows that there is a wide variation in the results obtained by different persons with different sieves analysing the same sand.

It would therefore appear that an advantage would result if it is feasible to obtain from different manufacturers sets of testing sieves made with sufficient accuracy and uniformity to render calibration for sand grain sizes unnecessary.

POINTS TO BE CONSIDERED IN CONNECTION WITH TENTATIVE STANDARDS

The question arises as to whether the proposed standard specifications of the American Society for Testing Materials fulfill these

[1] Presented before the Buffalo Convention, June 11, 1926. Prepared under the direction of the Standardization Council.

TABLE 1

Requirements for sieve openings and wire diameters with permissible variations

DESIGNATION, MICRONS	CORRESPONDING UNITED STATES STANDARD SIEVE SERIES NUMBER	SIEVE OPENING		WIRE DIAMETER		TOLERANCE IN AVERAGE OPENING, PER CENT	TOLERANCE ON WIRE DIAMETER, PER CENT		TOLERANCE IN MAXIMUM OPENING, PER CENT
		mm.	in.	mm.	in.		Under	Over	
1	2	3	4	5	6	7	8	9	10
4,760	4	4.76	0.187	1.27	0.050	±3	15	30	10
4,000	5	4.00	0.157	1.12	0.044	±3	15	30	10
3,360	6	3.36	0.132	1.02	0.040	±3	15	30	10
2,830	7	2.83	0.111	0.92	0.036	±3	15	30	10
2,380	8	2.38	0.0937	0.84	0.0331	±3	15	30	10
2,000	10	2.00	0.0787	0.76	0.0299	±3	15	30	10
1,680	12	1.68	0.0661	0.69	0.0272	±3	15	30	10
1,410	14	1.41	0.0555	0.61	0.0240	±3	15	30	10
1,190	16	1.19	0.0469	0.54	0.0213	±3	15	30	10
1,000	18	1.00	0.0394	0.48	0.0189	±3	15	30	10
840	20	0.84	0.0331	0.42	0.0165	±5	15	30	25
710	25	0.71	0.0280	0.37	0.0146	±5	15	30	25
590	30	0.59	0.0232	0.33	0.0130	±5	15	30	25
500	35	0.50	0.0197	0.29	0.0114	±5	15	30	25
420	40	0.42	0.0165	0.25	0.0098	±5	15	30	25
350	45	0.35	0.0138	0.22	0.0087	±5	15	30	25
297	50	0.297	0.0117	0.188	0.0074	±6	15	35	40
250	60	0.250	0.0098	0.162	0.0064	±6	15	35	40
210	70	0.210	0.0083	0.140	0.0055	±6	15	35	40
177	80	0.177	0.0070	0.119	0.0047	±6	15	35	40
149	100	0.149	0.0059	0.102	0.0040	±6	15	35	40
125	120	0.125	0.0049	0.086	0.0034	±6	15	35	40
105	140	0.105	0.0041	0.074	0.0029	±8	15	35	60
88	170	0.088	0.0035	0.063	0.0025	±8	15	35	60
74	200	0.074	0.0029	0.053	0.0021	±8	15	35	60
62	230	0.062	0.0024	0.046	0.0018	±8	15	35	90
53	270	0.053	0.0021	0.041	0.0016	±8	15	35	90
44	325	0.044	0.0017	0.036	0.0014	±8	15	35	90

Note.—Screens having larger openings than those included in the table may be specified, but in specifying screens of larger openings the actual size of the opening (in millimeters or in inches) shall be stated. A tolerance of ±3 per cent on average openings and of 10 per cent in maximum openings shall be permitted.

requirements. These standard specifications (see table 1) are essentially the same as those formerly adopted by the United States Bureau of Standards and recommended by the American Society of Testing Materials as set forth in the 1925 report of Committee No. 18, the main difference being that, instead of designating sieve sizes by the number of meshes to the inch, or by the diameters of average openings in millimeters or inches, it is proposed to designate sieve sizes by diameters of openings expressed in microns. It is argued that if this is done it is unimportant what diameters of openings are used in a set of sieves as long as the sieves are accurately and uniformly made and so long as the openings are known with a proper degree of accuracy. Inches or millimeters will serve the purposes of designating the sieve opening, but the micron being a very small unit the diameter of sieve opening would always be expressed in whole numbers.

From the scientific point of view there can be no objections to the principles upon which the standards are based. The main objections lie in the practical application of these principles with special reference to (1) keeping imperfections and the tolerances for wire and diameter of openings within proper bounds for use in sand analysis, (2) use of sieves without reference to ratio between sieves, (3) use of microns as a unit of measure.

LIMIT OF TOLERANCES IN SIEVE OPENINGS AND WIRE DIAMETERS

If tolerances in diameters of sieve openings and wire diameters can be kept within proper bounds, in other words, if one can rely on obtaining testing sieves of a satisfactory degree of uniformity, then it would be permissible to make comparisons of sand on the basis of sieve openings rather than on the basis of mean diameters of sand grains. For the time being, however, it would be desirable to multiply the separations as indicated by sieve openings by 1.1 which will give approximately the mean diameter of the largest sand grains passing given sieves. This factor is a variable one depending on the shape of sand grains and on sieve opening, but for ordinary separations used in filter sand analysis, variation in the factor would probably not be more than about 6 or 7 per cent. It is desirable to express analyses in terms of sand grain diameters in order to make them comparable directly with the mass of data already accumulated in connection with the analysis of sand. Some data relating to the relative size of sieve opening and diameter of sand grain were

given in the report of the sand committee in 1918. It should be noted, however, that comparatively little work has been done on the determination of the relation between sieve opening and sand grain diameter and it would seem to be desirable for the Committee to make some further investigations along these lines during the coming year, especially if the tendency to use uncalibrated sieves continues and if it is found feasible to obtain more perfect sieve cloth than heretofore.

The committee is not yet prepared to recommend the use of uncalibrated sieves for sand analysis even though it be possible to obtain testing sieves complying with the proposed standard specifications for it appears from investigations made by Hazen that pieces of wire cloth of the same weave and apparently of the same perfection do not give the same calibration within 5 per cent, due, apparently, to inequalities in the weave that have not thus far been overcome. It is possible that a thorough examination of testing sieves such as is made now by the United States Bureau of Standards may reveal and lead to a way of correcting these inaccuracies, but this has not as yet developed. It may be noted parenthetically that it is desirable to have testing sieves used for examination of sand examined by the United States Bureau of Standards.

The main objection in using uncalibrated testing sieves, therefore, narrows down to the thus far undemonstrated ability of manufacturers of testing sieves to weave sieve cloth with sufficient uniformity and freedom from imperfections to cause the variation in the calibrated maximum mean diameter of sand grain, passing different sieves made up of the same mesh of sieve cloth, to fall within the tolerances permitted in sieve openings. The committee will, therefore, endeavor to interest workers with a view to obtaining some data on the percentage error that will result from the use without calibration of testing sieves made up according to standards and after having been examined for tolerances and imperfections by the United States Bureau of Standards. This line of investigation would also give some further data of value on the ratio of size of sand grain to sieve opening.

USE OF SIEVES WITHOUT REFERENCE TO RATIO BETWEEN SIEVE OPENINGS

As pointed out in the 1925 report of the Committee it is desirable to have the sieve sizes vary in the ratio of the fourth root of two.

There should be no material variation from this ratio as is suggested might be done if the sieve opening is given in microns. This ratio already has the merit of fairly general adoption and offers many conveniences in plotting and calculation. By omitting every other sieve the set will vary in the ratio of the square root of two. This represents the largest number of sieves that can be conveniently handled in testing sand and the smallest number that will give a smooth and reliable curve even on logarithmic plotting paper. In fact, with this minimum number of sieves it is important to maintain the same ratio and the same size of sieve openings to obtain concordant results. (See 1925 Report for sieve openings to be used when using sets varying in the ratio of the square root of two and in the ratio of two.) To preserve the ratio of sieve openings in a set of testing sieves no variation in sieve openings should be permitted other than those that fall within the limits of the tolerances.

THE USE OF MICRONS AS A UNIT OF MEASURE

In the past there has been criticism on the part of filter contractors and dealers in filter sand against the present methods of expressing the results of sand analyses. It is claimed that the use of the millimeter scale and the use of such terms as "effective size" and "uniformity coefficient" are so far removed from the current usages of these people as to render them incomprehensible and that the contractor adds a substantial amount to his price to cover the "ignorance factor." It is questionable if these claims are entirely true because a number of dealers in filter sand now are able to furnish and actually do furnish sand on the basis of specified effective size, uniformity coefficient and stipulations as to certain maximum percentages which may be coarser than or finer than certain designated limiting sizes.

Nevertheless, some truth must be recognized as to the cumbersome character of these terms and their lack of harmony with ordinary commercial standards of measurement in this country. Therefore, the question may be raised as to what attitude contractors and dealers would take toward the term "micron" which is but little known outside of scientific laboratories. There is no good reason why engineers should not speak and think in terms of microns and the introduction of the term may be of benefit to them in deal-

ing with methods of examining filter sands. In the matter of specifying sand, however, it is believed best to continue referring to sand grain sizes in millimeters.

AS TO THE TERMS EFFECTIVE SIZE AND UNIFORMITY COEFFICIENT

The terms effective size and uniformity coefficient as defined by Hazen were developed by him as having a relation to friction losses suffered by water passing through sand beds with fine and coarse grains uniformly mixed as obtains in slow sand water filters or intermittant sand sewage filters and for such beds these terms have an important significance.

The general introduction of rapid sand filters for water purification has largely concentrated thought on the conditions of filtration in this type of filter, and the character of sand required to meet such conditions. The outstanding difference between a rapid sand filter bed and other sand filters results from the method of cleansing rapid sand filters, namely, by a reverse current of wash water which liquefies the whole bed resulting in pronounced stratification, with the fine sand at the top and the coarse sand at the bottom. The fine sand at the top together with the superincumbent film of coagulant and dirt constitutes the real filtering medium while the coarser sand constitutes a supporting medium. The terms effective size and uniformity coefficient, are relatively meaningless when applied to the bed as a whole and there is a belief among a number of the members of the Committee that the terms should either be discarded or their definition revised.

At present, the relations between the functioning of the upper and lower parts of the sand beds in rapid sand filters are obscure, and therefore it is difficult to devise a factor or coefficient that accurately characterizes the filtering qualities of a given sand. Some suggest a definition of effective size as that size of which 1 per cent, 2 per cent or some other per cent under 10 per cent is smaller than, in recognition of the active part which the fine sand plays at the top of the filter. Others would consider the filter bed divided into two parts, namely, the upper 2 to 6 inches (the filtering medium) and the remainder of the bed (the supporting medium). They would describe these two sands separately using effective size and uniformity coefficient as now defined.

RELATION BETWEEN UPPER AND LOWER LAYERS OF A RAPID SAND FILTER BED

The most rational method of describing sand as it actually lies in rapid sand filters is to indicate the sizes of sand in different strata. Just what are the significant strata is difficult to say, but as a basis to start upon the committee recommends a separate examination of strata in a 30 inch filter bed as follows:

0 inch depth to ½ inch depth
½ inch depth to 2 inch depth
2 inch depth to 6 inch depth
6 inch depth to 12 inch depth
12 inch depth to 20 inch depth
20 inch depth to 30 inch depth

By studying the behavior of rapid sand filters from the point of view of the stratification of the filtering medium there is little doubt that more light will be shed on the character and grading of sand most desirable in such filters and it should also be helpful in more fully explaining and overcoming some of the difficulties such as short runs, cracking, mud balls and air binding, now encountered in the operation of rapid sand filters.

The committee would appreciate having as many filter operators as practicable plot the stratification of their sand beds and submit the results together with a statement of any peculiarities in the behavior of the beds. This will permit the initiation of statistical studies that may greatly improve rapid sand filter operation.

DESCRIPTION OF FILTER SAND IN SPECIFICATIONS

In the foregoing the examination of filter sand has been discussed primarily from the point of view of its behavior in filter beds. Methods of examining sand with reference to its behavior in filter beds may also be useful in specifying filter sand for purchase, but not necessarily so. There has been more or less confusion in the minds of many regarding this difference. Hazen in formulating the terms uniformity coefficient and effective size had in mind convenient terms for describing the filtering properties of sand. In specifying sands for purchase it appears to have been his custom to designate the percentages above or below certain sizes corresponding to separations by calibrated sieves. Engineers in general found the terms effective size and uniformity coefficient less laborious to write into

a specification than the separations by means of calibrated sieves. Moreover, few engineers or dealers in sand had calibrated sieves and standard sieves of any degree of reliability were not on the market. Hence, engineers fell into the easy way of using some well sounding scientific terms which made no awkward reference to sieve separations that could not be checked. Actually these terms are not adapted to and were not intended to be used as terms for specifying a sand for purchase. Filter contractors and some sand dealers in course of time located certain natural sands of excellent quality which would fulfill usual requirements as to effective size and uniformity coefficient so the use of these terms has not worked out altogether badly. But these terms are not accurately descriptive of the type of sand required for rapid sand filters. They can perhaps be used to get the kind of sand desired, if in addition it is specified that not more than a stated small percentage shall be coarser than a given maximum desirable size and not more than a stated small percentage shall be finer than a given minimum desirable size, but this reverts to sieve separations which might have best been used alone and in the first place.

This is merely a progress report to stimulate discussion and it is hoped by the committee that this discussion will be active both in meeting and by letter.

Respectfully submitted,

PAUL HANSEN, *Chairman*,
GEORGE F. CATLETT,
EDWARD S. CHASE,
CHESTER M. EVERETT,
HARRY F. FERGUSON,
WILLIAM GORE,
GEORGE C. HABERMEYER
P. B. STREANDER,
JAMES E. WILLIAMSON.

REPORT OF COMMITTEE NO. 9 ON STANDARD SPECIFICATIONS FOR CAST IRON PIPE AND SPECIALS[1]

Since the 1923 Report, the work of the undersigned Committee has been limited to coöperation in the formation of a Sectional Committee of the American Engineering Standards Committee, composed of representatives of many associations and of the manufacturers, and which is about to start on its work of developing an American Standard Specification for Cast Iron Pipe and Special Castings, covering in its investigation all phases of the problem, and including all uses of the product.

As the future proceedings and conclusions of this A. E. S. C. Sectional Committee may be of substantial interest to the members of this Association, it is proposed to describe the general scheme and objective of the A. E. S. C., and more particularly the method by which a so-called Sectional Committee is developed.

The American Engineering Standards Committee, initiated in 1917 by joint action of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers, and the American Society for Testing Materials, has for its main objective "the formulation of some method of coöperation to prevent duplication of standardization work and the promulgation of conflicting standards." It undertakes to serve as a national clearing house for engineering and industrial standardization. It is primarily an administrative and policy forming body and, of itself, does not take up the technical details of any standard, but concerns itself rather with broader questions, such as—whether all interested organizations have had an opportunity to participate in the standardizing work, that the standard has been developed under proceedings which are "open, regular and above board," and that it represents "a real national consensus of opinion of what is best in American engineering and industrial practice, and hence that it either does or may reasonably be expected to play a significant, if not a controlling, rôle in the processes and materials in the industry concerned."

[1] Presented before the Buffalo Convention, June 9, 1926. Prepared under the direction of the Standardization Council.

The executive authority is vested in the Main Committee, composed of representatives of a group of national organizations, which now include seven departments of the federal government, nine national engineering societies and seventeen national industrial organizations, which are known as member bodies, and which are responsible for the whole movement.

The A. E. S. C. does not initiate standardization projects, which must start from some request by a responsible body. When such a request is made, the subsequent procedure is framed to insure to all interests concerned due participation in the work in hand. The procedure generally includes a formal conference to which representatives of all associations and manufacturers, possibly interested, are invited, and at which it is decided—whether the work of standardization shall be undertaken; if so, what its scope should be; how shall the work be organized? If the decision is to proceed, the scope of the project is outlined at this conference and a Sponsor or Sponsors are appointed—subject to the approval of the Main Committee. The duty of the Sponsors is to organize the Sectional Committee, which does the actual work and makes the technical decisions leading to the formulation of the standard in question. As Sponsors, one or more of the principal organizations interested are selected—these bodies being responsible, as already stated, for the organization of the Sectional Committee, for seeing that the work is effectively prosecuted and for providing for the necessary administrative and clerical service and for the publication of the standard. In carrying out these duties, the Sponsors, if more than one, appoint representatives who form a so-called Steering Committee, which is the active body to select the organizations to be represented on the Sectional Committee, and to determine the number of representatives to be allotted to each organization. In dealing with standards of a commercial character, a Sectional Committee must be made up of consumers, producers and general interests groups, and no one of these groups may form a majority, except with the consent of the other two. The objective is the formation of a well balanced committee, but consideration may be given to the relative importance of the several organizations in fixing the number of representatives allotted to each on the committee.

The Sectional Committee, thus developed from the engineering and manufacturing associations primarily interested in the standardization project, does the technical work. In other words, the

A. E. S. C. provides the machinery of coördination, but turns the investigational and standardization work over to those organizations most interested. Certain control of results is, however, maintained. The report of a Sectional Committee—after approval of the Sponsors—must be approved by the A. E. S. C. before it can be issued as a Tentative American or American Standard, but in its review of the work of the Sectional Committee the A. E. S. C. does not enter into the technical detail, but concerns itself wholly with general policy.

In short, the entire A. E. S. C. scheme of operation is designed to bring into any project of standardization all interested organizations, to guarantee such participation that there can be no possibility of steam roller practices, to decentralize the actual technical work and turn it over to those most concerned in the problem, and finally to review in wide perspective the results obtained.

The method as above described may appear complicated, but it is undoubtedly justified by the objective of making possible the development of a standard which will be generally acceptable and used. It is because of the greater possibility of producing such a standard specification for cast iron pipe under the auspices of the A. E. S. C., than if attempted independently, that your Committee has concluded that the best interests of this Association lie in co-operation.

Having thus described the general scheme of the A. E. S. C. procedure, the events leading to the development of the recently formed Sectional Committee on Cast Iron Pipe will now be briefly recorded.

On November 21, 1922, the American Gas Association submitted its standard specification for cast iron pipe and special castings to the A. E. S. C. for approval as standard. This application was referred to a special committee of fifteen members, made up from the A. E. S. C. Main Committee and of representatives of various organizations—including this Association—which were invited to participate.

Before the Committee met, the American Society for Testing Materials had also submitted its specifications for approval, and this Association, through its chosen representative, had taken the position that a new standard specification should be based on a review of the fundamentals of qualities of iron and better coatings, and that—until these primary factors could be further investigated, dimensional standardization, which was largely the objective of the

A. G. A. application, was of secondary importance. The Special Committee voted on October 4, 1923, to defer approval of any existing standard specifications, pending broad consideration of the subject by a general conference, fully representative of all interests involved, with the object of determining whether standardization of cast iron pipe should be undertaken; if so, what shall be the scope of the work; how shall the project be organized?

The conference was held in New York on June 5, 1924—forty-eight representatives of thirty-five different organizations and manufacturers being present. The principal results of this meeting were a decision to undertake the unification of cast iron pipe specifications, the development of an outline of the scope of the project, and the selection of sponsor organizations.

As adopted, the scope of the work is as follows:

> Unification of specifications for bell and spigot cast iron pipe, including materials, dimensions, pressure ratings; methods of manufacture (including such new developments as centrifugal casting), in so far as they may be necessary to secure satisfactory specifications; elimination of unnecessary sizes and varieties; consideration of the possibility of developing a coördinated scheme of metallic pipe and fittings applicable to all common mediums; and methods of making up joints in so far as they are determining as to the dimensional design of cast iron pipe.
>
> The types of cast iron pipe to include: flanged pipe; flanged and bell mouth fittings and wall castings; pipe elbows, tees, Y's, return bends, and other fittings not now included in standard lists; cast iron pipe threaded for flanges or couplings; soil pipe and other lighter types of cast iron pipes and fittings—but not to include: methods of installing pipe and similar matters, except for the making up of joints in its relationship to the dimensional standardization of pipe and fittings as noted above.

As Sponsors of the project, the conference selected the American Gas Association, the American Society for Testing Materials and the American Water Works Association, and these organizations, after approval by the A. E. S. C., together with the New England Water Works Association, which was subsequently added, were invited to serve and to name representatives who would form the Steering Committee—the active body in the organization of the Sectional Committee.

The Steering Committee, which included Messrs. Morris, Warwick, McInnes and Barbour—after several meetings in New York and much correspondence—determined on the organizations to be represented on the Sectional Committee and the number of members to be allotted to each.

Thus developed, the Sectional Committee is now made up as follows:

American Gas Association

H. E. Bates, Assist. Chief Engineer, Peoples Gas Light and Coke Co., Chicago.

Walton Forstall, Engr. of Dist., United Gas Improvement Co., Philadelphia.

W. Cullen Morris, Chief Engr., Consolidated Gas Co., New York.

C. C. Simpson, Jr., Gen. Supt. of Mains and Services, Consolidated Gas Co., New York.

American Water Works Association

F. A. Barbour, Consulting Engineer, Boston, Mass.

W. W. Brush, Deputy Chief Engr., Dept. of Water Supply, Gas and Elec., New York.

W. C. Hawley, Chief Engr. and Gen. Supt., Pennsylvania Water Co., Wilkinsburg, Pa.

E. E. Wall, Water Commissioner, St. Louis, Mo.

T. H. Wiggin, Consulting Engineer, New York.

New England Water Works Association

W. R. Conard, Burlington, N. J.

F. A. McInnes, Consulting Engr., Boston, Mass.

C. W. Sherman, Consulting Engr., Boston, Mass.

American Society for Testing Materials

S. R. Church, New York.

Richard Moldenke, Consulting Metallurgist, Watchung, N. J.

C. L. Warwick, Secretary Treasurer, A.S.T.M., Philadelphia.

American Society of Civil Engineers

F. H. Stephenson, Assist. Supt., Detroit Dept. of Water Supplies, Detroit.

American Society of Mechanical Engineers

F. S. Finlay, Jr., New York.

J. E. Gibson, Mgr. and Engr., Water Dept., Charleston, S. C.

American Railway Engineering Association

C. R. Knowles, Supt. Water Service, Illinois Central Railroad, Chicago.

U. S. Bureau of Standards

L. S. Fairchild, Washington, D. C.

National Fire Protection Association

C. W. Mowry, Director, Factory Mutual Laboratories, Boston.

Underwriters Laboratories

A. W. Cluassen, Assist. Eng., Chicago.

At Large

L. P. Wood, Assist. Eng, Board of Water Supply, 2217 Municipal Bldg., New York.

American Standardization Society of the Valve and Fittings Industry

C. R. Wood, 400 Chestnut St., Philadelphia.

Cast Iron Pipe Manufacturers.

Shellman B. Brown, Supt., Warren Foundry and Pipe Co., Phillipsburg, N. J.

A. M. Campbell, Glamorgan Pipe and Foundry Co., Lynchburg, Va.
George Castor, Vice President, Donaldson Iron Co., Emaus, Pa.
K. S. Clow, Vice President, J. B. Clow and Sons, Chicago, Ill.
A. M. Ford, Assist. Engr., National Cast Iron Pipe and Foundry Co., Burlington, N. J.
W. G. Hammerstrom, Lynchburg Foundry Co., Lynchburg, Va.
D. P. Hopkins, Vice President, U. S. Cast Iron Pipe and Foundry Co., Burlington, N. J.
W. D. Moore, Pres., American Cast Iron Pipe Co., Birmingham, Ala.
N. F. S. Russell, Pres., U. S. Cast Iron Pipe and Foundry Co., Burlington, N. J.
D. B. Stokes, Gen. Sales Mgr., U. S. Cast Iron Pipe and Foundry Co., Burlington, N. J.
Walter Wood, R. D. Wood and Co., Philadelphia, Pa.

Consumers' representation	16 members
Producers' representation	12 members
General interests	7 members
Total	35 members

The first meeting of the Sectional Committee was held in New York on April 21 and 22, 1926—twenty-five members being present. The Committee elected as officers, Thomas H. Wiggin, Chairman, N. F. S. Russell, Vice Chairman and C. C. Simpson, Jr., Secretary, and as an executive board the three officers and eight additional members of the Sectional Committee, Messrs. Barbour, Brush, Campbell, Moore, Morris, Sherman, Warwick and Wood. Regulations for the government of the Sectional Committee were tentatively adopted—subject to confirmation in final form by letter ballot.

Three Technical Committees were appointed by the Executive Committee, as follows:

Technical Committee No. 1—Dimensions
W. C. Hawley, Chairman pro tem.
Technical Committee No. 2—Metallurgy, Processes and Tests
H. E. Bates, Chairman pro tem.
Technical Committee No. 3—Corrosion and Coatings
S. R. Church, Chairman pro tem.

The chairmen of these Technical Committees are to meet with the Executive Committee during this convention, for the further development of the detailed program of the work to be undertaken.

The membership of technical committees is not limited to members

of the Sectional Committee, thus making it possible in particular problems to invite the coöperation of specialists. Such members of technical committees, however, have no vote on the Sectional Committee.

The foregoing statement of the personnel and officers of the Sectional Committee is here made in order that the members of this Association may be informed as to the men who will be active in the A. E. S. C. Cast Iron Pipe Standardization Work during the next year or two. The investigations of the Committee will undoubtedly involve the sending out of some questionnaires, and it is hoped that our members will appreciate the necessity of coöperation and will give prompt and careful attention to any communications sent them.

As a Sponsor, the A. W. W. A. is responsible for a share of the expenses of the Sectional Committee, which share will probably range between $250 and $400 per year. The Consolidated Gas Company of New York has very generously agreed to permit C. C. Simpson, General Superintendent of Mains and Services, to serve as Secretary of the Sectional Committee, and to supply necessary stenographic and miscellaneous services required in the secretarial work, without expense to the Committee.

Representatives of the manufacturers have agreed with the Steering Committee to finance liberally any justifiable investigational work.

The scope of the project is planned on comprehensive lines; the organizations coöperating well represent the consumer, producer and general interest groups; the personnel of the Committee justifies anticipation of valuable results; it is proposed to keep the membership of the various associations informed of progress made from time to time.

Respectfully submitted,

FRANK A. BARBOUR, *Chairman*,
WM. W. BRUSH,
WM. C. HAWLEY,
N. F. S. RUSSELL,
EDWARD E. WALL,
THOMAS H. WIGGIN,
WALTER WOOD.

WATER SUPPLY SITUATION IN NEW JERSEY[1]

By H. T. Critchlow[2]

The object of this paper is to outline the present water-supply situation in the State of New Jersey and give a brief review of history of events leading thereto.

LEGAL PROCEDURE

Prior to 1907. The right to develop water supplies for public use must be granted by the State before water may be legally diverted. In the early days special charters were granted to several private corporations for engaging in the water business, and giving them the right to divert water from certain sources for meeting the needs of their respective territories. Most of these grants were in perpetuity and many of these corporations or their successors are still operating under the original charters. A number of municipalities throughout the State are now operating under these special charters obtained through purchase from the private corporations or by direct grant from the legislature.

Several water companies are operating under the General Corporation Act of 1875, but most of them that began operation prior to 1907 are incorporated under the General Water Act of 1876. Previous to 1876 municipalities received direct grants to develop a water supply from the legislature. In that year the Water Act relating to cities was passed. Other acts were passed in later years relating to other civil divisions and governing their procedure in water supply development.

Diversion Act. In 1907 the general Water Diversion Act (chapter 252, P. L. 1907) was passed establishing a State Water Supply Commission, defining its duties and powers, and the conditions under which waters of the State may be diverted. This Act, which is still in force, makes it necessary for all municipal corporations,

[1] Presented before the Buffalo Convention, June 10, 1926.

[2] Chief, Division of Waters, Department of Conservation and Development, Trenton, N. J.

private corporations or persons to obtain the approval of their plans for diverting new or additional water supplies from surface streams, lakes or ponds. A supplement passed in 1910 (Chapter 304, P. L. 1910) extended the jurisdiction of the State Water Supply Commission to include diversions from well, sub-surface or percolating sources.

These diversion laws provide that after hearing on an application the Commission shall decide (1) whether the plans proposed are justified by public necessity or reasonably anticipated public use, and (2) whether such plans interfere unduly with the opportunity of other municipalities to obtain a water supply necessary for their use, and, when a surface source is involved, (3) whether the reduction of the dry season flow of any stream will be caused to an amount likely to produce unsanitary conditions, and (4) whether the diversion from either surface or sub-surface sources will unduly injure public or private interests. In approving an application the Commission has power to attach reasonable conditions covering such points, as (1) limit of grant, (2) amount of diversion, (3) territory to be supplied, (4) time limit for construction, (5) reversion to State in case of abandonment and proviso for approval in case of transfer of rights, (6) recapture by State, (7) maintenance of required flow in stream below point of diversion, and (8) additional storage requirement. All decisions are subject to review by the courts for reasonableness, legality and form.

On July 1, 1916, the duties and powers of the former State Water Supply Commission in regard to jurisdiction over the diversion of waters under the acts of 1907 and 1910 were vested in the Board of Conservation and Development (Chapter 241, P. L. 1915).

District Act. About the same time, the District Commission Act (Chapter 70, P. L. 1916) was passed, dividing the State into a north and south district, and a companion act (Chapter 71, P. L. 1916) authorized the appointment of a commission in each district. The Commission may be brought into being by any municipality or group of municipalities petitioning the Governor for its appointment to act as their agent in developing a water supply. The North Jersey District Water Supply Commission was appointed under this Act at the request of the cities of Newark and Paterson to study the Wanaque Project. Prior to the establishment of the District Commission each city had separately petitioned the State Water Supply Commission for permission to develop a new water

supply on the Wanaque River. These petitions were denied, primarily because this water shed was one of the few remaining undeveloped nearby sources of water supply, and could not be given to one municipality without unduly interfering with the opportunity of the other to get a supply.

The Act provides that the work of development be done under a contract between the District Commission and the municipality or municipalities joining in the project. Accordingly, the City of Newark contracted in October 1918 with the North Jersey District Water Supply Commission for the development of the Wanaque Project. The State Board of Conservation and Development granted its approval for this project, first for a diversion of fifty million gallons daily, and in 1924 approval was given for development of the maximum amount economically obtainable from the Wanaque River and Post Brook adjacent thereto. The estimated amount to be developed has been generally considered to be one hundred million gallons daily. This increased amount was made necessary by the desire of the other municipalities, including Paterson, Passaic, Clifton, Montclair, Glen Ridge, Bloomfield and Kearny to join Newark in this undertaking. The entire expense is borne by the municipalities and in proportion to the amount of water they contract to take. No commission has yet been appointed for South Jersey because no municipality in that district has requested it. The present district plan, it should be noted, divides the entire State into two districts, each of which includes large rural areas besides the metropolitan areas; also that the District Commission may be brought into being at the request of any municipality in the district, and thus placing the entire district—rural as well as urban areas—under the jurisdiction of the Commission brought into being to develop a water supply for a specific urban area. The District Commission is primarily a constructing and operating body for the municipality or municipalities that voluntarily engage its services through contract; but the law governing it also requires any municipality in the district to get the approval of the Commission before it may obtain any new or additional water supply from any watershed other than the watershed or watersheds from which said municipality obtains its existing supply.

As mentioned before, the present District plan depends upon voluntary coöperation on the part of the municipalities in making contracts with the Commission for constructing water supply proj-

ects. While this plan has worked in the case of the Wanaque Project, progress has been slow and at times the work was threatened with failure due to a lack of partners to join in the undertaking. If the Commission had more power and authority to go ahead and get a project started and require coöperation on the part of such municipalities naturally situated so as to be best served by a given water supply project, the whole problem of water supply for the metropolitan areas could be handled more expeditiously and in a more businesslike way. Furthermore, the present physical situation in the North Jersey Metropolitan District (generally taken as the six counties of Bergen, Hudson, Essex, Passaic, Union and Middlesex), in regard to the lack of a reserve between supply and demand for water from present sources, is now so critical that only the most complete coöperation on the part of all municipalities in the Metropolitan District will assure the adoption of a comprehensive plan for water supply development to meet future requirements and prevent precipitate action in the event of a water famine.

Home Rule Act. As mentioned before, the State Board of Conservation and Development is empowered by law to exercise general supervision over the development of the water resources of the State. This Board, however, is neither empowered nor organized to undertake construction work. That is left to the initiative of the individual municipalities, water companies, or the District Commission as agents for a group of municipalities.

At the present time there are four legal methods by which every municipality may provide its inhabitants with a new or additional water supply, as set forth in the so-called "Home Rule Act" passed in 1917 (Chap. 152, P. L. 1917).

a. By making either singly or jointly with other municipalities a contract with the District Water Supply Commission for such a supply as they may desire.

b. By making contracts from time to time, for a period not exceeding 15 years, with other municipalities having water works, or with private water companies.

c. By purchasing or leasing from their present owners existing water works which now supply them. In case of disagreement as to price, the municipality has the power to condemn the property, plant and rights of the private owner.

d. By acquiring necessary lands, water and flowage rights, either by purchase or condemnation and constructing their own water works.

PHYSICAL SITUATION

On the physical side there is no shortage of natural water resources. Mr. Allen Hazen in his report in 1922 on the Water Resources of New Jersey and their Development stated that "there is scarcely a state in the Union so favorably situated for providing the water supply for a great Metropolitan District."

Present condition. The water shortage which was so keenly felt throughout the State during the dry summer of 1923, was due primarily not to the temporary deficiency of rainfall, but to the fact that the developed sources of supply lacked the reserve capacity required to meet the demand during the period of low precipitation.

The reserve capacity in a dry year of the sources now developed for the supply of the metropolitan district (the counties of Bergen, Essex, Hudson, Middlesex, Passaic and Union) is but 7.8 per cent in excess of the present demand. For the remainder of the State the reserve is about 10 per cent of the demand. When it is realized that the demand for water increases at the rate of about 3 per cent per year, the gravity of the present situation is apparent.

The North Jersey District Water Supply Commission as mentioned before is now developing a new supply from the Wanaque River for the municipalities of Newark, Paterson, Passaic, Clifton, Glen Ridge, Montclair, Bloomfield and Kearny. This supply is expected to be ready for use in 1928. Careful estimates indicate that even after the completion of the Wanaque supply, the demand for water in the metropolitan district will reach the quantity then developed by about the year 1935, and this development is of no benefit to the remaining 18 counties of the State.

Local developments. This critical situation has arisen largely because of the local character of the existing developments. That is, each municipality or water company has acquired a source of supply and developed its source to meet the growing demand of its own consumers, with little regard for the existing or future needs of its neighbors. Many of these local sources have now been developed to the limit of their yield and in order to obtain additional quantities of water the municipality or water company must seek more distant sources, the development cost of which exceeds the financial resources of the municipality or company. The growth of local pride in the excellence and economy of the supplies developed by each particular municipality or company has militated against coöperative development. The competition between adjacent

municipalities and companies for readily available sources, which has necessarily become keen with the increasing demand for water, has inevitably led each developer to think of his neighbor as an opponent rather than as an ally.

Coöperative development. The Wanaque Development by the North Jersey District Water Supply Commission, already mentioned, is the first successful attempt at municipal coöperative development of water supply within the State. It is a step in the right direction, but the law creating this Commission confines the activities within rather narrow limits. First, the Commission can undertake the investigation of new sources of supply only when petitioned to do so by a municipality desiring such an investigation and upon the agreement of the municipality to pay the cost of the investigation. Second, the Commission can construct water supply works only after executing a contract or contracts with the municipality or municipalities desiring to obtain water, by which each contracting municipality agrees to pay its just proportion of the total cost of the works. Third, the Commission has no powers or jurisdiction outside of the 12 counties comprised in the North Jersey District (Sussex, Warren, Hunterdon, Passaic, Morris, Monmouth, Somerset, Bergen, Hudson, Essex, Union and Middlesex).

Except for the municipalities mentioned above as partners in the Wanaque Development, no municipality within the North Jersey District has volunteered to coöperate with its neighbors in the development of a new supply through the facilities of the Commission. The North Jersey District Water Supply Commission is therefore unable to proceed with the development of supplies in addition to the Wanaque project, though it stands ready and willing to do so.

STATE WATER POLICY

For many years the State government has been endeavoring to formulate and put into effect a definite program of water supply development which should assure the economic utilization of the water resources and their just apportionment to each community. These efforts began in 1882 with the appointment of the State Water Supply Commission, "to determine upon plans for the storage of any of the waters of the State for the purpose of furnishing to cities and towns a joint water supply." The report of this Commission has been followed by reports and recommendations of subsequent commissions until there are now available a number of

well considered plans for the solution of the water supply problem. Due in some degree to legal obstacles, but principally because of the apathy of the public, no definite plan for water supply development has ever been adopted and the present critical situation has resulted.

Water Policy Commission. Desiring to review and coördinate all of the available information as a basis for definite action, the Legislature of 1925 created a Water Policy Commission and directed this Commission to formulate a comprehensive State Policy with reference to the development of the waters of the State, to recommend the instrumentality through which such policy should be carried into effect and the ways and means for the financing thereof, to study and recommend appropriate action upon the proposed compact between the states of New York, Pennsylvania and New Jersey, which apportions to these three states the waters of the Delaware River, and to report upon the practicability and advisability of interstate treaties regarding other interstate streams; and to report its findings to the Legislature of 1926.

The report of the Commission has recently been submitted to the Legislature, in two parts. Part One deals with the proposed compact as to the water resources of the Delaware River and recommends that the compact be not ratified in its present form, but that a commission be appointed to continue negotiations with the states of New York and Pennsylvania. The report also recommends that a commission be appointed to negotiate with New York as to the rights of New York and New Jersey in the waters of the interstate streams of said states, including Hackensack, Ramapo, Pochack and Wallkill Rivers.

Part Two of the report deals with the problem of developing an adequate supply of potable water for the entire State and methods to be employed in securing such supply. This report contains recommendations which if adopted will make considerable change in the present procedure of developing water supplies. Immediately upon receipt of this report, the Legislature resolved to meet in special session on June 22, 1926, to consider exclusively the water situation. The Water Policy Commission has been continued by legislative action to extend their studies and prepare bills embodying their recommendations for the consideration of the Legislature at the special session.

A summary of the conclusions and recommendations of the Water Policy Commission with observations on certain of them follows:

1. The water supply problem is regional in character and not statewide. Two centers of population are recognized as having regional problems,—(*a*) The northern metropolitan district, including the counties of Essex, Hudson, Bergen, Passaic, Middlesex and Union, and, (*b*) the southern metropolitan district, including the counties of Mercer, Burlington, Camden and Gloucester along the Delaware River. There is no doubt about the need for water in the northern metropolitan district. In the southern part of the State, the City of Trenton and environs, which is located in Mercer County, should be able to get an adequate water supply from the Delaware River, if it is properly protected from pollution, for many generations. The City of Camden and vicinity is rapidly increasing in its water consumption, but the present sources of supply are in no immediate danger of being overdeveloped. On the other hand, Atlantic City and environs, which is not included in the southern metropolitan district, has a serious water problem at the present time.

2. The disapproval by the Water Policy Commission of a plan for a single State agency to solve the problem is based upon the belief that any financial support from bond issues would not receive the approval of the electorate of the entire State, as the Constitution now provides.

3. The Commission recommends that the State should proceed without unnecessary delay to acquire the ownership, as distinguished from actual development for water supply purposes, of the remaining undeveloped major sources of supply. It is recommended also that this be entrusted to an agency of the State to acquire ownership and hold the same until needed for development. The carrying out of this recommendation would require a State bond issue with the necessity for a referendum vote. The plan would seem to provide for payment to the State of the cost of acquiring and holding these sources of supply by the communities which later develop them for potable water.

4. The Commission recommends that the division of the State into the two water supply districts be continued, and that the act providing for the creation of a commission for each district be maintained. The North Jersey District Water Supply Commission having been brought into existence, it is recommended that a

South Jersey District Water Supply Commission should be constituted; also that until such action is taken, the power, authority and jurisdiction of such commission be vested in and exercised within the Southern district by the Board of Conservation and Development. In this connection, it should be remembered that the two districts into which the State is now divided are *not* limited to the metropolitan areas, but include roughly the northern and southern halves of the State with their large rural areas. It is also proposed to enlarge the powers of the district commissions, which at the present time are limited to the construction and operation of joint water supply projects for groups of municipalities which may voluntarily make contracts with the Commission. The suggested additions to their powers include the adoption of comprehensive plans to meet both the local and regional needs of the entire district; also to control all developments within the district made by municipalities, corporations or persons. The recommendation is made that the district commissions also be given power to interconnect existing water supply systems when in their judgment such interconnection will better serve the people of the metropolitan district.

5. The Water Policy Commission recommends that in general the power, authority and control over water supplies now vested in the Board of Conservation and Development should be transferred to and vested in the district commissions, to be exercised within their respective districts; also that the number of members of the district commissions should be increased from four to seven, to be appointed by the Governor, with the advice and consent of the Senate,—four members to be resident of the metropolitan region and three members resident of the district outside of the metropolitan region. If this recommendation is adopted, the statewide supervision of undeveloped sources of water supply will be turned over to district commissions whose principal work will be the development and operation of water supply systems for the metropolitan areas within their districts. The question to be here considered is whether or not it is a just and sound principle of administration of water resources in the interests of all the people of the State to give this control to the district commissions, or whether it should be entrusted to a central State Board, which has no direct interest in the construction and development of water supplies for metropolitan areas, but whose principal duty is a general super-

vision over all the sources of potable and public water supply; and whether such a central State Board would be in a better position to decide impartially which watersheds in the rural areas of the State should be developed for the metropolitan areas and under what conditions they should be developed, not only to meet the needs of the metropolitan areas, but also to protect the interests of the rural communities. The other fundamental question to be considered in this connection is whether the district commission should have jurisdiction over not only the metropolitan, but also the rural areas, such as is proposed in continuing the sub-division of the State into districts, or whether the districts should be limited to the metropolitan areas alone which are or will in the future need water supplies from rural areas. The adjudicating of questions which are bound to arise between the metropolitan and rural communities in connection with water-supply development for Metropolitan areas is generally difficult to solve. Witness the recent problem in the Massachusetts Metropolitan District. Furthermore, it would seem that communities outside the metropolitan districts should have the right, after obtaining approval of a central State Board, of developing their own sources of supply so long as they do not interfere with a major project which the district commission may have proposed for future water-supply development.

The idea back of increasing the membership of the district commissions from four to seven members seems to be to give the rural communities representation, but aside from creating a large board, which experience has shown does not generally function as well as a small board, there is considerable doubt whether the interests of the rural communities would be amply protected by such an arrangement.

6. It is proposed by the Water Policy Commission that whenever any development to be made by one district commission involves the utilization or affects the sources of supply in the other district, application for the consent of the commission of the latter district should be required. If agreement between the district commissions cannot in such case be reached, jurisdiction should be vested in the State Board to determine the issue between the commissions. This is a matter which would be taken care of in a much more direct manner by limiting the district commissions' authority to the metropolitan areas and that developments of new sources of supply be subject to the approval of a State Board. This would also take

care of the diversion of water from the channel of the Delaware River by one district, which might affect the opportunities of another district to take water from the same source. This is an important matter, inasmuch as the Delaware River is the most important future source of water supply in the State.

There are two other points which it would seem are important enough to require special consideration and legislation. One is the conserving of the existing developed sources of supply by the compulsory metering of all consumers, in order that they will not waste or use water extravagantly. Universal metering is becoming more and more the solution of the elimination of waste in many of our cities. There are many convincing examples in which the installation of service meters has postponed the necessity for making large additional developments for many years, and thus saved large expenditures in capital. The other point relates to the protection of our developed and also our undeveloped sources of water supply from pollution. While it is recognized that streams are the natural carriers of the drainage and wastes of our communities, there should be some definite policy adopted, such as establishing zones on our streams within which the discharge of wastes is definitely regulated in such a manner as to protect the quality of the water supplies for potable use, and also protect the channel of the streams against unsanitary conditions and against public nuisances which may not necessarily be dangerous to public health, but are certainly detrimental to the public welfare.

The present state of flux in the water situation in the State of New Jersey therefore affords an opportunity to adopt a Water Policy which will not only solve the present critical situation, but also lay the foundation which will assure the wise development of the State's water-supply resources, for the security and comfort of the present population and the protection of coming generations.

REPORT OF THE WATER POLICY COMMISSION OF NEW JERSEY—PART II[1]

A Review

By George L. Hall[2]

The Water Policy Commission was directed by the Senate and General Assembly of New Jersey to formulate "a comprehensive State policy with reference to the development of the waters of the State, the recommendation of the instrumentality or instrumentalities through which such policy should be carried into effect, and the ways and means of financing thereof." The task of bringing together the large volume of existing data bearing upon the problems to be considered, and revising, supplementing and coördinating these was delegated to Nicholas S. Hill, Jr., Consulting Engineer.

Sixty-eight per cent of the population of the State is within the so-called Northern Metropolitan District, which roughly comprises the Counties of Bergen, Passaic, Essex, Hudson, Middlesex and Union. The Southern Metropolitan District embracing the Counties of Mercer, Burlington, Camden and Gloucester, contains 16 per cent of the population of the State, or, in other words, 84 per cent of the population of the entire State reside in these two districts.

In the Northern Metropolitan District there are 175 incorporated communities having a total population of 2,360,000, 93 per cent of whom are served by 40 public water supplies of which 22 are publicly and 18 privately owned. The total water consumed is approximately 250 m.g.d., derived from sources with an available yield of 300 m.g.d. The existing available supplies may possibly suffice for the next four years if effectively pooled by interconnecting. The Wanaque River project, now under construction by the North Jersey District Water Supply Commission, is to be completed by the end of 1928. Its yield is estimated as affording 100 m.g.d., but notwithstanding this addition shortages of serious proportions will exist in parts of the District.

[1] Prepared under date of February 27, 1926.

[2] Division Engineer, Maryland State Department of Health, Baltimore, Md.

The Southern Metropolitan District comprises some 105 incorporated communities with a total population of 542,000, 87 per cent being served from 48 public supplies, 19 of which are publicly and 29 privately owned. The present water consumption is approximately 50 m.g.d., and the safe yield of the sources now developed is about 84 m.g.d., sufficient for possibly eight or ten years to come. Trenton has unlimited supply available from the Delaware River; Camden has developed a supply of over 16 m.g.d. from underground sources, while the bulk of the water used in the remainder of the district is developed in small units from wells and such supply may be augmented by driving additional wells. It may therefore be some time before the necessity for a large regional supply becomes actually imminent.

The rest of the State has an area about double that of the two metropolitan districts combined with about one-sixth of the State's population. In this area there are 250 incorporated small and widely scattered communities. Sixty-seven per cent of the population is supplied with water by 109 plants, of which 57 are publicly and 52 privately owned. The general problem of water supply is not likely to arise in this territory such as that existing in the Northern and Southern Metropolitan Districts, with the possible exception of Atlantic City and a few similar places.

Both the northern and southern sections of the State, where the population density is greatest, have available sources from which water may be obtained. The northern towns have the Hackensack, the Passaic, the Raritan and their tributaries, together with the tributaries of the Delaware. Provided suitable arrangements can be made with New York State the drainage area of the Wallkill will also be available. In the south are the Rancocas, Wading, Mullica, Great Egg Harbor and Maurice Rivers all of appreciable size. In addition to these sources, if, as proposed, a Delaware Tri-State Compact is entered into, approximately 1500 million gallons additional water will be available from the Delaware for use in the northern and southern portions of the State. Total available resources, including New Jersey's share of the flow of the Delaware, of 4000 m.g.d. are indicated.

In addition there are certain underground horizons in various parts of the State which yield appreciable quantities of water. The importance of ground water as a source of supply is indicated by the fact that in 1924 more than one quarter of the total daily output

was ground water. Although the greater part of the population is served with surface water, there are about three times as many systems serving ground water as there are serving surface water.

Eighty-eight per cent of the population of the State is served with water from public supplies. Seventy-one per cent of the total daily amount of water used is consumed in the Northern Metropolitan District and 14 per cent in the Southern Metropolitan District.

Studies of future population and growth in water consumption indicate that the water requirements in the Northern Metropolitan District will have more than trebled in the next fifty years and in the Southern Metropolitan District will have increased a little more than two and one-half times. These facts make it evident that there is not, and probably will not be for many years to come, any regional water supply problem outside of the two metropolitan districts. They also show that the problem is more pressing in the Northern Metropolitan District than in the Southern.

The water supply problem in the Northern Metropolitan District is discussed with brief outlines of the projects under way and those that have been and are now under consideration for relief from present or anticipated water shortages, and a brief description of sources now developed and of sources which are available are presented. From this discussion it appears that following the natural lines of past development the District divides itself into three sections:—the northern, including the area now served by the Hackensack Water Co., and other territory in Bergen County; the central, supplied mostly from the Passaic and its tributaries; and the southern, which includes the territory supplied by the Plainfield-Union, Elizabethtown and Middlesex Water Companies.

Comparison of the water consumption in the Northern Metropolitan District with the yield of the various supplies indicates that there is at best but a margin of a few years before the consumption of the District as a whole will exhaust the present sources. Conditions vary, however, in the several sections of the District. If the water resources could be effectively pooled and interchanged between sections the seriousness of existing conditions would be somewhat alleviated. Therefore, pooling and sectional interchange of such waters should be encouraged.

The adequacy of available sources is unquestioned. Their estimated yield is about ten times the present consumption. The

sufficiency of these sources will not be substantially affected by the fact that it may be necessary to refrain from further development of some of the available sources because of pollution or other causes. The estimated requirements in the District in 1980 will be a little over 1000 m.g.d., so that the selected sources will be adequate for fifty years and will allow latitude for choice in the sequence of development.

The conclusions relative to the situation in the Northern Metropolitan District are: That the situation confronting many of the communities in the District is serious in the extreme and will become more so during the next three years unless constructive remedial measures are adopted and made effective without delay; that the completion of the Wanaque development in the latter part of 1928 will help out the situation as it affects certain communities, but will not wholly meet, even temporarily, the conditions which give rise to serious concern; that it is feasible to interconnect the existing water systems to provide an interchange of water; that plans for such interconnections should be promptly adopted and put into execution; that local supplies should be further developed where interconnections will not supply local needs temporarily; that it will be necessary in addition to the above to execute certain of the minor projects included in a piecemeal construction program, so that conditions which will exist until supplies developed through a major project are available may be met; in selecting a minor project for development the question whether it may be utilized after the completion of the major project, or whether its cost will be such that it will be cheaper to amortize such cost than pay interest on the cost of the major project will enter; and, on account of the time required for the preliminary steps in such an undertaking, the major project should now be determined upon and its execution put under way.

Because of the above reasons the Commission has not determined which of the two major projects should be adopted, nor to what extent the program of piecemeal construction should be executed. This determination should be made and controlled by the permanent commission having jurisdiction within the District. The situation is critical, the consequences of delay are menacing and immediate and continuous constructive action is of utmost importance.

A regional water supply problem will soon confront the Southern Metropolitan District. The safe yield of the available sources as

now developed will possibly meet the requirements during the next eight or ten years. If a situation similar to that now existing in the Northern Metropolitan District is to be avoided effective steps toward meeting the need must be taken without delay. The problem was foreseen as early as 1911 by the then State Water Supply Commission and means of meeting it were considered in a report to the Commission by Harry R. Humphreys.

Subsequent to the submission of this report the State Water Supply Commission entered into a contract to purchase the Wharton Tract for one million dollars. This action was made the subject of a test suit to determine whether it violated the State Constitution. The Court of Errors and Appeals, reversing the decision of the lower court, determined that the bond issue could not be effected without affirmation of the people of the State. This was done and resulted in the rejection of the proposal.

It is the conviction of the Commission that the sources of supply and necessary lands, referred to in Mr. Humphreys' report, should be acquired without delay.

A brief review of existing legislation in the State is given relating to the control over sources of water supply vested in Board of Conservation and Development. This Board succeeded the State Water Supply Commission and has all the powers of the latter, except insofar as such jurisdiction and powers are restricted by the statutes constituting and relating to water supply districts.

The report contains the following conclusions and recommendations

1. There is no single State problem of water supply development, but there are regional problems in the Northern and Southern Metropolitan Districts; the problems in the remainder of the State are local rather than regional; the problem in the Northern Metropolitan District varies in imminence and seriousness in the three sections into which it divides itself, and the problem in the Southern Metropolitan District is not as serious or pressing as in the Northern, but preparation to meet it should not be delayed.

2. No attempt should be made to meet these varying problems through centralizing jurisdiction, control and power to make developments in a single agency.

3. The State should proceed without delay to acquire in ownership, as distinguished from actual development for water supply purposes, the remaining undeveloped major sources of water supply and the lands necessary for their conservation and protection, and to provide for forestation of such lands.

4. As a first step, a bond issue be submitted to a State referendum, for the purpose of requiring the sources of supply and lands referred to in the report of Mr. Humphreys, and the sources of supply and protecting lands required in the next major project that may be determined to be most advantageous to meet the regional demands of the Northern Metropolitan District.

5. It may be necessary ultimately in maintaining a comprehensive policy for the State to acquire sources of supply or already developed or partially developed major sources.

6. No new State agency be created for acquiring the aforementioned sources of supply and lands; and that for this purpose the Board of Conservation and Development act as agent for the State.

7. The division of the State into two water supply districts be continued; and that the act providing for North and South District Water Supply Commissions be maintained.

8. The South Jersey District Water Supply Commission be constituted, and until this step is taken all authority which would be possessed by it should be vested in and exercised within the district by the Board of Conservation and Development.

9. The district commissions, in addition to the powers now vested in them, be directed to prepare and adopt comprehensive plans for both local and regional needs within their districts; and no water supply developments within the districts should be permitted except in accordance with these plans. Wherever advisable provisions should be made in these plans for connections between privately owned systems and any major development adopted, upon just and reasonable compensation.

10. The direction for the preparation and adoption of such comprehensive plans should in no wise affect the full exercise of the powers and jurisdiction of the Commissions pending the fulfilment of such direction.

11. Power should be vested in the district commissions to require the inter-connection of public water supply systems, whether publicly or privately owned, and the interchange of water, on equitable terms and conditions affording fair compensation to be subscribed by such commissions.

12. The power, authority and control originally vested in the State Water Supply Commission and now vested in the Board of Conservation and Development, together with the powers vested in this Board by the Act Concerning Municipalities, should be

now developed will possibly meet the requirements during the next eight or ten years. If a situation similar to that now existing in the Northern Metropolitan District is to be avoided effective steps toward meeting the need must be taken without delay. The problem was foreseen as early as 1911 by the then State Water Supply Commission and means of meeting it were considered in a report to the Commission by Harry R. Humphreys.

Subsequent to the submission of this report the State Water Supply Commission entered into a contract to purchase the Wharton Tract for one million dollars. This action was made the subject of a test suit to determine whether it violated the State Constitution. The Court of Errors and Appeals, reversing the decision of the lower court, determined that the bond issue could not be effected without affirmation of the people of the State. This was done and resulted in the rejection of the proposal.

It is the conviction of the Commission that the sources of supply and necessary lands, referred to in Mr. Humphreys' report, should be acquired without delay.

A brief review of existing legislation in the State is given relating to the control over sources of water supply vested in Board of Conservation and Development. This Board succeeded the State Water Supply Commission and has all the powers of the latter, except insofar as such jurisdiction and powers are restricted by the statutes constituting and relating to water supply districts.

The report contains the following conclusions and recommendations

1. There is no single State problem of water supply development, but there are regional problems in the Northern and Southern Metropolitan Districts; the problems in the remainder of the State are local rather than regional; the problem in the Northern Metropolitan District varies in imminence and seriousness in the three sections into which it divides itself, and the problem in the Southern Metropolitan District is not as serious or pressing as in the Northern, but preparation to meet it should not be delayed.

2. No attempt should be made to meet these varying problems through centralizing jurisdiction, control and power to make developments in a single agency.

3. The State should proceed without delay to acquire in ownership, as distinguished from actual development for water supply purposes, the remaining undeveloped major sources of water supply and the lands necessary for their conservation and protection, and to provide for forestation of such lands.

4. As a first step, a bond issue be submitted to a State referendum, for the purpose of requiring the sources of supply and lands referred to in the report of Mr. Humphreys, and the sources of supply and protecting lands required in the next major project that may be determined to be most advantageous to meet the regional demands of the Northern Metropolitan District.

5. It may be necessary ultimately in maintaining a comprehensive policy for the State to acquire sources of supply or already developed or partially developed major sources.

6. No new State agency be created for acquiring the aforementioned sources of supply and lands; and that for this purpose the Board of Conservation and Development act as agent for the State.

7. The division of the State into two water supply districts be continued; and that the act providing for North and South District Water Supply Commissions be maintained.

8. The South Jersey District Water Supply Commission be constituted, and until this step is taken all authority which would be possessed by it should be vested in and exercised within the district by the Board of Conservation and Development.

9. The district commissions, in addition to the powers now vested in them, be directed to prepare and adopt comprehensive plans for both local and regional needs within their districts; and no water supply developments within the districts should be permitted except in accordance with these plans. Wherever advisable provisions should be made in these plans for connections between privately owned systems and any major development adopted, upon just and reasonable compensation.

10. The direction for the preparation and adoption of such comprehensive plans should in no wise affect the full exercise of the powers and jurisdiction of the Commissions pending the fulfilment of such direction.

11. Power should be vested in the district commissions to require the inter-connection of public water supply systems, whether publicly or privately owned, and the interchange of water, on equitable terms and conditions affording fair compensation to be subscribed by such commissions.

12. The power, authority and control originally vested in the State Water Supply Commission and now vested in the Board of Conservation and Development, together with the powers vested in this Board by the Act Concerning Municipalities, should be

transferred and vested in the district commissions to be exercised within their respective districts.

13. The number of members of the district commission be increased from 4 to 7.

14. Whenever any development to be made in one district affects the sources of supply in the other district, the consent of the commission of the latter district should be required. In case no agreement can be reached the Board of Conservation and Development should have jurisdiction to determine the issue.

15. Each district commission should be required to file with the Board of Conservation and Development a certified copy of all grants of consent made. The latter Board should also continue to study stream flow, occurrence and movements of underground waters and to collect statistics of water consumption.

16. The Board of Conservation and Development should be empowered to complete the compilation of grants of rights of diversion heretofore made by the State to, and now held by, municipal corporations, corporations and persons.

17. Sources of supply acquired by the State as hereinbefore suggested should be made available to the municipalities of the two districts.

18. The acts of the district commissions should be subject to judicial review.

19. Appropriation should be made by the State to each of the commissions to cover the costs of administration which are attributable to the performance by such commissions of State functions assigned to them.

20. Certain existing laws should be repealed, and the statutes relating to public water supplies in general should be revised, unified, harmonized and simplified.

21. The situation facing the communities in the State and especially in the Northern Metropolitan Region is serious and does not admit of delay; a prompt determination of the future general policy of the State is essential since regional interest in undertaking a major project is difficult of unification to the point of action as long as expectation or hope of the undertaking by the State itself of a major development prevails.

In Appendix III of this report, *Underground Water Resources*, David G. Thompson, Associate Geologist, U. S. Geological Survey, discusses the results of an investigation of quantities of ground water available for public and industrial supplies in New Jersey.

More detailed investigative work was done in the Atlantic City region than any other part of the State.

The territory covered in this study extends from Brigantine to Corsons Inlet and includes the mainland towns from Absecon to Somers Point. The Atlantic City water supply averaging 11 m.g.d. in 1924, is obtained partly from Absecon Creek and partly from wells 100 to 200 feet deep on the mainland. The supply for the mainland towns, about 0.5 m.g.d. comes from a small creek and relatively shallow wells. The supply for all the beach towns from Brigantine to Ocean City and for many hotels and industrial plants in Atlantic City, is pumped from wells penetrating the so-called Atlantic City or 800-foot sand which lies at that depth. This is the only horizon that can be used along the beach; all other beds yielding only salt water or too small quantities to be of value. The total average daily quantity now pumped from this horizon is estimated to be about 5 m.g. in winter and 10 m.g. in summer. The surface water supplied Atlantic City, although safe from a sanitary standpoint, at times is dirty and has a bad odor.

At first thought it may seem that the required quantity of water can be developed from the 800-foot horizon in Atlantic City, but this investigation indicates that it would be unwise to attempt this. Since the first wells were drilled, in 1893, the static head on the formation in Atlantic City has been lowered from its original position of about 20 feet above sea level to 60 feet or more below sea level, a total drop of about 80 feet. It has likewise been lowered from 30 feet to 70 feet in all wells between Brigantine and 55th Street, Ocean City, and as much as 25 feet at the Atlantic City water works on the mainland where there had been no pumping until May, 1925. There is evidence that the area in which there has been a lowering of the head extends several miles beyond the points mentioned and presumably several miles oceanward. Except for the past one and one-half years no accurate data as to the rate of lowering are available, but it appears to be more or less directly related to the rate of pumping and therefore to progress according to the yearly increase in pumpage. When the pumpage decreases in fall and winter the head rises somewhat and drops again as pumpage increases in summer.

If an additional draft of 6 to 10 m.g.d., that necessary to replace the surface water supply for immediate needs alone, is imposed upon the formation in Atlantic City, it is evident that the static

head will be lowered very greatly, probably to at least 150 feet below sea level.

Of more importance is the possible invasion of the horizon by salt water, if the head is pulled down too far. Although several wells have "gone salt" it has been rather conclusively shown that the salt water has entered from overlying beds through defective casings. So far as the author has been able to ascertain, conditions in Atlantic City, relating to the salt water problem, are without a parallel in that where wells situated so close to the ocean with salt water above and probably below have been pumped heavily without drawing in salt water. Experience in other localities shows that if the invasion by salt water does occur it may take place rapidly, and once it has happened the formation may be permanently spoiled. This would very seriously affect the shore communities which are not entirely dependent upon the 800-foot horizon. This horizon may be penetrated at a less depth on the mainland but there is little question but that any large draft would cause a considerable lowering of the head over an area comparable to that resulting from the present pumping in Atlantic City. The head in Atlantic City would undoubtedly be lowered considerably, although perhaps not as much as if the additional draft occurred right in the city. There would be, nevertheless, danger of invasion by salt water. It is the author's opinion that the 800-foot horizon should not be drawn upon at any point for the Atlantic City supply, but should be left for the smaller beach communities which cannot afford to go to the mainland for water. There remains for the use of Atlantic City the shallow horizons on the mainland and the streams some distance inland. It appears that a considerable quantity of water can be obtained from the shallow horizons, but if shallow wells are placed too near the bay there is danger of salt water, so that in the development of such wells the city should proceed with caution making tests to be sure contamination from this source is eliminated by the proper location of the wells.

Emphasis is placed on the fact that the problem of economic and prudent utilization of the ground water resources of the Atlantic City region is not that of Atlantic City alone, but of all the communities in a considerable area. The question is raised as to whether it will not be desirable, in the near future, for these communities to form a district for the purpose of developing its water resources in the wisest and most economic manner, with due regard for the natural conditions that control the occurrence of the ground water supplies.

SUMMARY OF WATER LEGISLATION PASSED BY THE NEW JERSEY LEGISLATURE AT A SPECIAL SESSION HELD IN JUNE, 1926

By H. T. Critchlow[1]

Chapter 342 appropriates to the Water Policy Commission the sum of $25,000. This Commission was appointed by the legislature of 1925 to make a report on the water situation in New Jersey.

Chapter 343 is an amendment to the Water Supply District Act providing for the confirmation by the Senate of the appointment of members to the District Commissions proposed by the Governor.

Chapter 344 gives to the Water Policy Commission power on behalf of the State of New Jersey to negotiate with commissioners for New York and Pennsylvania regarding the development and utilization of the waters of the Delaware River and its tributaries.

Chapter 345 gives to the Water Policy Commission power on behalf of the State of New Jersey to meet with commissioners for the State of New York to investigate and report upon the development and utilization of the water resources of the interstate streams of the two states other than the Delaware River.

Favorable action was taken by the Legislature on a proposed amendment to the Constitution giving to the Legislature power to establish water supply districts, sewerage districts, drainage districts, and meadow reclamation districts; providing for the appointment of commissioners for such districts to carry out the projects in any of these matters for a particular district, and also conferring powers of taxation, assessment and bond issue. This requires favorable action by the Legislature of 1927 and also favorable vote by the electorate at a following special election before the amendment becomes effective.

[1]Chief, Division of Waters, Department of Conservation and Development, Trenton, New Jersey.

DISCUSSION

H. F. DUNHAM:[1] The paper upon Intakes of the Great Lakes Region[2] by George H. Fenkell rewards attention and finds a permanent place in the records of difficult undertakings. Machinery available at the period was often taxed to near its full limit as at Racine where a submerged intake connection had a cover of 10 feet below the normal lake bottom in water 40 or more feet deep. The best lake dredges were needed and at Milwaukee an artificial lake bottom was placed *over* the tunnel excavation.

No mention was made of the advantage under ice conditions of reversing the flow to help overcome the trouble. The writer back in the 80's and 90's placed two submerged intakes in Green Bay in about 24 feet of water. They were of iron perforated by many small openings and arranged to take water at different elevations. (Descriptions have been published.) The installation which was without standpipe or reservoir provided for discharging water through one intake while taking it through the other, and for many years there was little trouble and no shortage in the supply. For a larger installation it would not be necessary that the connecting intake lines should be of equal diameter.

Many years ago when the city of Milwaukee was suffering from ice trouble, the writer suggested to the late Dr. George H. Benzenberg, then Chief Municipal Engineer of that city, the advantage of an electric cable circuit and use of current from the traction line in off peak hours. Several letters passed in discussion of the best method of providing electrical resistance at the intake. This was two or three years before the first service pipe was thawed out by electric currents. Afterward we remarked upon the great advantage of giving attention to minute instead of large affairs.

[1] Civil Engineer, New York, N. Y.
[2] JOURNAL, September, 1926, page 267.

SOCIETY AFFAIRS

THE ANNUAL CONVENTION

The American Water Works Association opened its forty-sixth annual convention at the Hotel Statler, Buffalo, New York, during the week of June 7, 1926. The attendance was one of the largest in the history of the Association. It reached almost thirteen hundred, over two-thirds of whom were members and the remainder guests.

Afternoon Session, June 7. At 2:30 p.m. an informal meeting was held. W. S. Cramer presided. The meeting was well attended and was marked by lively discussions of the subjects treated. The first of these, "Periodic vs. Continuous Readings and Billings for Water Companies and Departments," was opened by a short paper by H. P. Bohmann, followed by a paper by J. E. Gibson on the same subject. Those taking part in the discussion included H. P. Bohmann, E. G. Smith, V. B. Siems, D. C. Grobbel, C. M. Crowley and others.

The second subject to be taken up was "Diversion of the Funds of the Municipally Owned and Operated Water Plant to Use of other Departments of the Municipality." This subject was discussed by D. C. Grobbel, John Chambers, J. A. Foulks, George H. Fenkell, H. P. Bohmann, V. B. Siems, A. E. Phillips, J. F. Pierce, H. B. Lee, Zode Smith, J. W. Kelsey, W. S. Rathbun, William Luscombe, C. M. Crowley, and others.

The third topic discussed was "Use of Pulverized Fuel in the Water Works Plant." This was very freely discussed by many of the members. The discussion centered upon the experience[1] of the Des Moines, Ia., Water Works Plant, under the management of C. S. Denman. In part, Mr. Denman called upon G. A. Conrath, Chief Mechanical Engineer of the Des Moines plant, who went more fully into the details of the system. He also answered numerous questions by members as to the economy, safety and general workings of the system of pulverized coal for the steam boilers.

[1] Journal, September, 1926, page 296.

At the conclusion of this discussion, the session adjourned until the Wednesday evening session, when several other topics were discussed at considerable length by the members. Among the subjects were "Advantages and Benefits Derived from Waste Water Surveys," which was discussed by H. P. Bohmann, E. S. Cole, W. A. Patton, W. A. McCaffery, D. A. Heffernan, J. F. Pierce, R. E. McDonnell and others.

Other subjects treated at the meeting were "Fast and Slow Meters," "Essential Log Data of Daily Operations of the Plant by the Chief Engineer," and "Landscape Gardening and Improvement of Grounds Around Water Works Plant."

In the evening of June 7, an informal reception and dance was held under the auspices of the water works manufacturers Association.

Morning Session, June 8. President Huy opened the convention proper on Tuesday morning by reading the list of those who had passed away during the year. He then called upon the Rev. Mr. Loomis who delivered a prayer. The address of welcome was by Water Commissioner Bryan G. Boyle of Buffalo, who represented Mayor Schwab and the Commissioner of Public Works, in their absence.

The chair then announced the election of the officers for the ensuing year, as follows:

President: Allan W. Cuddeback, Engineer and Vice-President, Passaic Water Co., Paterson, N. J.

Vice-President: James E. Gibson, Manager and Engineer, Water Department, Charleston, S. C.

Treasurer: William W. Brush, Deputy Chief Engineer, Department Water Supply, Gas and Electricity, New York City.

Trustees: Dist. 3: Fred E. Beck, Chief Engineer, Consolidated Water Co., Utica, N. Y. Dist. 5: J. O. Craig, Superintendent Water Works, Salisbury, N. C. Dist. 7: Theodore A. Leisen, Gen. Mgr., Met. Util. Dist., Omaha.

The reports of the Secretary and Treasurer were then given briefly by B. C. Little and W. W. Brush. The report of the Executive Committee was also given by B. C. Little. Two sections had been admitted during the year, those of the Rocky Mountain and Montana, making a total number of 14 sections.

B. C. Little also announced for the executive committee that Chicago had been selected as the convention city for 1927.

The next order of business was the award of the John M. Diven Memorial Medal. This is a new bronze medal to be awarded yearly to the member who in the judgment of the Executive Committee had performed the greatest service to the association during the preceding year. The Chair called upon Alexander Milne to award the medal. He presented it to George W. Fuller, Chairman of the Standardization Council, for the remarkably effective work he had done in the preparation of the Manual and as head of the Standardization Council.

The report of the committee on the increase of dues was read. This recommended the increase, as follows: Active members, from $7 to $10; corporate members, from $10 to $15; associate members from $15 to $25. The report emphasized the necessity for this change, as, among other matters of finance, it would enable the association to employ a permanent secretary.

The motion to increase the dues according to the report was made and carried unanimously.

The report of the Committee on Standardization of Meter Dials[2] was read by W. W. Brush for Charles W. Sherman, Chairman.

The committee on Brass Fittings reported progress, and hoped by the next convention to have a definite schedule of standardization ready. The Committee on the Standard Form of Contract, J. Waldo Smith, Chairman, also reported progress.

George W. Fuller reported on the work of the Standardization Council. Regarding the Manual of Water Works Practice, he said it was entirely up to the membership as to whether a second edition of the Manual would be issued. If the members give the Council their reaction and show that a revision is desired, then it will be revised and only then. He said that the Standard Methods of Water Analysis had been well received in Europe and that a committee of the League of Nations had sponsored several translations of this work into foreign languages. He also spoke of the work of the Committee on Boiler Feed Water, and the coöperation received from many of the great associations of the country in this field.

The nominating committee organized and nominated the following ticket for officers for the 1927–28 convention year:

James E. Gibson, Manager and Engineer, Water Department, Charleston, S. C. for president.

[2] Journal, November, 1926, page 666.

William W. Brush, Deputy Chief Engineer, Department Water Supply, Gas and Electricity, New York City, for vice president.

George C. Gensheimer, Secretary, Commissioners of Water Works, Erie, Pa., for treasurer.

Seth M. Van Loan, Deputy Chief, Bureau of Water, Philadelphia, Pa., for Trustee, District 2.

L. R. Howson, Alvord, Burdick and Howson, La Grange, Ill., for Trustee, District 8.

The Executive Committee recommended the election of the following as honorary members: G. G. Earl, General Superintendent, Sewerage & Water Board, New Orleans; Robert H. Thomas, retired, Lowell, Mass.; J. L. Tighe, Consulting Engineer, Holyoke, Mass.; Col. R. M. Clayton, retired, Atlanta, Ga.

George H. Fenkell, Superintendent of the Detroit Water Works, introduced a resolution from the Detroit Municipal Club, composed of 2500 employees of the city, expressing their thanks to the association for its work in bringing the matter of back income taxes of water works and other employees to the attention of Congress. In discussing the matter, William W. Brush told the association that there was every indication that, unless a United States Supreme Court decision intervenes, the water works men will have to pay income taxes for 1925. Col. Leisen said that he believed the imposition of such a tax would be extended to the water works themselves, and that such an action would precipitate a suit before the Supreme Court which would bring about the needed decision.

S. T. Powell reported for the Boiler Feed Water Committee that ten papers were to be presented before the association and also published on this subject.

The session closed with a paper by George C. Andrews, on the Water Works of Buffalo.

Afternoon Session, June 8. The first of the papers presented was on "Universal Metering,"[3] by John Ericson. The second paper was on "Coordination of Fire Fighting Facilities" by George W. Booth, Chief Engineer of the National Board of Fire Underwriters. The third paper was by H. E. Miller, on "Securing Improved Technical Supervision of Water Purification Processes."[4]

The next paper was by Nicholas S. Hill, Jr., on "The Use of Standpipes and Elevated Tanks to Reinforce the Distribution

[3] Journal, October, 1926, page 399.

[4] Journal, September, 1926, page 355.

System during Periods of High Demand."[5] This paper was discussed by MacDowell, Vinder, W. A. McCaffery, G. C. Habermeyer, E. G. Smith, W. A. Hendry, B. Russell, A. M. Bowman, E. D. Ruth, McCullough, N. M. R. Wilson, E. E. Minor, J. E. Gibson, W. S. Patton and others.

Evening Session, June 8. This session, under the auspices of the Water Works Manufacturers' Association, was presided over by Edgar Buttenheim, President of the Association.

The papers read were as follows: "Diesel Engine Driven Pumps," by Rodney D. Hall; "New Automatic Chlorinator," by Wm. J. Orchard; "The Story of Sandspun Pipe," by Charles R. Wood; "The Advantages of the Thin Plate Orifice vs. the Venturi Tube in Water Measurement,"[6] by G. D. Conlee; "From Mine to Consumer," a motion picture.

On Tuesday morning, the ladies of the convention were taken for a motor ride to Niagara Falls, and were given luncheon at the Falls. In the evening there was a card party on the mezzanine floor of the Statler Hotel. These features of the entertainment program were by the courtesy of the Water Works Manufacturers' Association.

Morning Section, June 9. The first paper was by Professor A. N. Talbot, Municipal and Sanitary Engineering, University of Illinois, on "Strength of Cast Iron Pipe."[7]

This was followed by the progress report of the Committee No. 9—Standard Specifications for Cast Iron Pipe and Specials.[8] This report was read by T. H. Wiggin, in the absence of Frank A. Barbour.

The next paper, by George H. Fenkell, was on "Flow Surveys as an Aid to Fire Protection." This paper was discussed by W. W. Brush, G. W. Booth, F. C. Jordan, D. A. Heffernan, J. N. Chester, C. W. Sherman and the author.

Afternoon Session, June 9. The first paper was on the "Use of Two Water Mains in Wide Streets," by Thomas F. Wolfe, Research Engineer, of the Cast Iron Pipe Publicity Bureau. Several instances of dual mains in wide streets were cited by D. W. French.

At this point the nominating committee of the Plant Management and Operating Division gave its report. Those named were, for Chairman, H. P. Bohmann; Vice-Chairman, J. Chambers;

[5] Journal, November, 1926, page 593.
[6] Journal, October, 1926, page 456.
[7] Journal, July, 1926, page 1.
[8] This Journal, page 794.

Trustees, W. S. Cramer, and James E. Gibson. These gentlemen were unanimously elected.

The next paper was on "Water Supply Works of the State of Florida," by E. L. Filby. It was followed by a paper by J. R. McWane, of the McWane Cast Iron Pipe Company, on "Standard Lengths of Cast Iron Pipe Cast Horizontally."[9]

O. B. Mueller read the next paper on "Service Pipes."[10] This paper was discussed by D. A. Heffernan, A. Milne, A. Collins, P. J. Hurtgen, D. W. French, P. Gear and others.

The final paper of the session was by Scotland G. Highland, on "Study of Year Round Soil Temperature from Zero to Depth of Six Feet Below Surface."[11]

Frank C. Jordan, Chairman of the Joint Committee on Fire Prevention, asked to have the report of this committee postponed until Friday, but asked the convention to hear Franklin H. Wentworth on the same subject. To this the chair acquiesced and called upon Mr. Wentworth to speak on the chiefs' cabinet.

Mr. Wentworth spoke of the immense good the association is doing and will do for fire prevention. He referred to the formation of the Fire Prevention Division, under the chairmanship of Nicholas S. Hill, Jr., and of the Joint Committee of Fire Prevention, under F. C. Jordan, coöperating with the National Fire Protection Association and the International Association of Fire Engineers.

Evening Session, June 9. A smoker was held on Wednesday evening, under the auspices of the Water Works Manufacturers' Association, the entertainment consisting of an international amateur boxing tournament. This was largely attended by the men of the convention. There was also provided, under the same auspices, a theatre party for the ladies at the Majestic Theatre. The ladies were taken on shopping tours during the afternoon.

Morning Session, June 10. "Study of Currents in Lake Erie, at Erie, Pa.,"[12] was the subject of a paper on Thursday morning, by D. E. Davis.

Frank C. Jordan reported as chairman of the Joint Committee on Fire Prevention.

Three papers were read and discussed during the morning ses-

[9] Journal, November, 1926, page 620.
[10] Journal, October, 1926, page 438.
[11] Journal, September, 1926, page 342.
[12] Journal, August, 1926, page 155.

sion, as follows: "The Water Supply Situation in New Jersey,"[13] by H. T. Critchlow; "Specifications for Riveted Steel Pipe with Regard to Hydraulic Characteristics," by H. A. Stringfellow; "Distribution Feeder Survey as a Basis for Improvement Studies,"[14] by V. Bernard Siems and E. K. Wilson.

Afternoon Session, June 10. The first paper of the afternoon session, at a joint session of the Plant Management and Operation and Fire Protection Divisions, was a "Discussion on Experience with Water Works Intakes in Great Lakes,"[15] by George H. Fenkell.

C. A. Holmquist read a paper on the experience in New York State on discontinuing cross-connections.[16] This subject was discussed by James M. Caird, H. A. Burnham, Mr. Barrier, C. M. Baker, H. F. Ferguson, Zode Smith, George W. Booth, Stephen H. Taylor, E. J. Lennon, and others.

The report of the Committee on Publicity was given by Frank C. Jordan.

Following this report an address was given by John C. Mellett, on the "Advantages of Publicity."

In the evening there was a dinner-dance through the compliments of the Water Works Manufacturers Association, at which considerably over one thousand members and guests were present.

Morning Session, June 11. A. F. Mellen spoke on "The Present Status of the Use of Iodides in Minneapolis Water Supply."[17] This paper was freely discussed and water works men from many cities showed great interest in the subject. Those taking part were J. M. Caird, H. E. Miller, B. C. Little, Hoyt, C. H. Spaulding, C. M. Crowley and others.

A paper on the "Progress on the Missouri River Water Works at St. Louis," was read by John C. Pritchard.

George D. Norcom discussed troubles with coagulating basins due to foaming and overturning. W. S. Cramer, L. H. Enslow and Malcolm Pirnie related various experiences with this form of difficulty and the remedies.

James M. Caird spoke on experiences with the rewash of filters. This subject was also treated by Malcolm Pirnie, F. W. Green, L. H. Enslow, J. B. Ferguson, A. U. Sanderson and others.

[13] This Journal, page 801.
[14] This Journal, page 705.
[15] Journal, September, 1926, page 267.
[16] Journal, September, 1926, page 330.
[17] This Journal, page 715.

Experience in the control of filter plants by the use of the hydrogen-ion method was discussed by C. R. Cox, W. A. Taylor, M. Pirnie, J. W. Bugbee, G. C. Habermeyer, W. S. Cramer and others.

E. C. Groner spoke on the workings and advantages of the flushometer type water-closet. This subject was discussed by Wm. Luscombe, D. A. Heffernan and N. M. R. Wilson, etc.

William W. Brush introduced a resolution condemning the interference of politicians in the orderly workings of the water department. This was carried.

Afternoon Session, June 11. At the final session of the Convention, the first subject discussed was "Algae, Treatment of Reservoir —Recent Experiences."[18] This was led by Frank E. Hale, who told of the work done in the Catskill System in ridding the reservoirs of various forms of organisms, and the use of copper sulphate in this connection. Others treating of this subject were W. W. Brush, C. W. Sherman, B. C. Little, P. Carlin, H. P. Bohmann and L. H. Enslow.

Cast iron pipe and the problems connected with its use came in for considerable discussion at this session, the De Lavaud centrifugally cast pipe[19] being referred to favorably by several of the speakers. Those taking part in this discussion included P. J. Hurtgen, James Sheahan, S. H. Taylor, R. B. Morse, F. W. Albert, D. A. Heffernan, R. E. Findlay, W. J. Willson, D. W. Van Gilder, T. H. Le Sage and N. M. R. Wilson.

A paper by James E. Gibson was read in his absence, by Mr. McDowell, treating on "Cement Lined Cast Iron Pipe."[20] This was discussed by W. W. Brush, Malcolm Pirnie, H. Y. Carson, S. H. Taylor, C. W. Sherman, T. H. Wiggin, D. A. Heffernan, G. S. Moore and others. The general sentiment in this discussion was that cement lining increased the age of the pipe and avoided interior corrosion and pitting. The coating of cement must, however, be of sufficient thickness to insure the covering of all tubercles in the pipe.

Water Purification Division

The first session of the Water Purification Division, under the chairmanship of J. W. Armstrong, was held at 2:00 p.m. on Wednesday. The papers read at this session were: "Experimental

[18] This Journal, page 765.

[19] Journal, September, 1926, page 373.

[20] Journal, October, 1926, page 427.

Studies of Water Purification by U. S. Public Health Service,"[21] by H. W. Streeter; "Earlier Determinations of B. Coli,"[22] by C. J. Lauter; "New Features of Water Purification Practice in Ohio,"[23] by Frederick H. Waring; and "A Cemented Gravel Slab—Vitrified Clay Pipe Distribution System for Rapid Sand Filters,"[24] by Harry N. Jenks.

On Thursday morning the main part of the division considered the following papers: "Observation and Experience in Eighteen Months Operation of Detroit Filtration Plant"[25] by W. M. Wallace; "Treatment of Public Water Supplies for the Prevention of Corrosion and Red Water,"[26] by John R. Baylis; "Experiences with Manganese in the Croton Water Supply," by Frank E. Hale; "Test and Operating Results of the Lime Dry Feed and Slaking Machines at Wheeling, W. Va., Filtration Plant," by J. F. Laboon. The Division also discussed the following subject: "What is the Purpose of the Underdrain System and Gravel Layer in a Mechanical Filter?"

Friday afternoon the division again met and the following papers were read: "The Hydraulic Jump as a Mixing Device," by A. G. Levy and J. W. Ellms; and "Special Features of Design of Buffalo Filtration Plant," by Clarke D. Parsons.

Progress reports of the following Committees of the Standardization Council were also read, as follows: "Standard Methods of Water Analysis," Jack J. Hinman, Jr.; "Practicable Loadings for Purification Processes," by H. W. Streeter; "Industrial Wastes in Relation to Water Supply,"[27] Almon L. Fales, chairman; "Filter Sand, Testing and Recording,"[28] Paul Hansen, chairman.

The Committee on Boiler Feed Water Studies

This subdivision of the Water Purification Division met at 9:00 a.m. Wednesday and 2:00 p.m. Thursday to consider the activities of Committee No. 19, Boiler Feed Water Studies. Ten papers were read as follows: "The Effect of Temperature on the Liberation of

[21] Journal, September, 1926, page 336.
[22] Journal, November, 1926, page 625.
[23] Journal, October, 1926, page 446.
[24] Journal, November, 1926, page 542.
[25] Journal, October, 1926, page 465.
[26] Journal, June, 1926, page 598.
[27] Journal, September, 1926, page 302.
[28] This Journal, page 786.

Hydrogen Gas by Corroding of Iron and Zinc," by John R. Baylis; "The Potentiometric Determination of Hydrogen Ion Concentration as Applied to Boiler Waters,"[29] by Willard N. Greer and Henry C. Parker; "Hydrogen-Ion Control in Water Purification," by W. A. Taylor; "Conductivity Methods of Measuring Condenser Leakage," by Henry C. Parker and Willard N. Greer; "Water Problems Encountered in Railroad Practice," by S. C. Johnson; "Chicago and Northwestern Railroad's Progress of Water Treatment," by R. E. Coughlan; "Possible Future Developments on Railroads," by C. R. Knowles; "The Problem of Steam Boiler Corrosion,"[30] by Frank N. Speller; and "Non-Condensable Gases in the Steam and their Control by Conditioning of the Boiler Water," by R. E. Hall.

At 6:30 p.m. on Thursday the Water Purification Division held its annual banquet in the Grill Room of the hotel with 107 men present. Harry E. Jordan was toast master and the speakers were: E. D. Bartow, C. W. Foulk and W. D. Collins.

Nicholas S. Hill, Jr. Membership Cup

The Hill cup was established a number of years ago by Nicholas S. Hill, Jr. who presented a cup to be given to the section of the American Water Works Association which made the greatest gain in membership during the year. This year (1926) it was won by the California Section which made a gain of 30%; that is, the Section had 120 members last year and a net gain of 36 this year, giving a present total of 156 active members.

CENTRAL STATES SECTION

The annual convention of the Central States Section was opened in Carnegie Hall, Cleveland, Ohio, on the morning of September 21, 1926, with President J. W. Ellms in the chair.

After a brief address by the President, W. R. Hopkins, City Manager of the City of Cleveland, was introduced and delivered a welcome to those attending the convention.

Owing to the absence of the secretary, C. F. Drake nominated A. G. Levy to act as secretary of the Convention. Levy was elected to fill the vacancy.

[29] Journal, November, 1926, page 602.
[30] Journal, July, 1926, page 72.

The first paper on the program was by Howell Wright, Director of Public Utilities, Cleveland, Ohio, entitled "Lake Erie as a Public Water Supply."[31] At the conclusion of Wright's paper, a discussion thereon followed, in which J. N. Chester, L. B. Harrison, Leo Hudson, J. W. Ellms and Crabbe of Saginaw, took part. After considerable discussion by these gentlemen, the closing comments were presented by the author of the paper.

A resolution was then presented by Howell Wright, seconded by C. F. Drake, as follows:

> That the Central States Section of the American Water Works Association, go on record as favoring another joint investigation of the whole problem of the Great Lakes, with reference to the question of pollution, and that the President of the Association be instructed to send the proper communications to the Federal State Department, to the U. S. Congress and to the Federal Health Department.

After some discussion the motion was carried.

The next paper presented was by W. U. Gallaher, the subject being "Dissolved Oxygen Changes During Filtration." This paper was discussed by J. N. Chester, P. J. O'Connor, J. W. Ellms, W. U. Lawrence, J. S. Scott, C. F. Drake and L. B. Harrison. The closing remarks were presented by W. U. Gallaher.

President Ellms then appointed a nominating committee, consisting of Geo. C. Gensheimer, D. C. Grobbel and C. J. Wetter, after which the meeting adjourned for luncheon.

The afternoon meeting was also held at Carnegie Hall, and was called to order by the President at 2:00 p.m.

The first paper presented was by J. W. Ellms, entitled "Perforated Pipe Type of Filter Strainer System Design." Much discussion followed regarding Mr. Ellms' paper in which some of the advantages and disadvantages of the pipe strainer system were brought out. Those taking part in the discussion were:—J. N. Chester, Philip Burgess, W. S. Clarke, and J. A. Fulkman.

At the conclusion of this discussion, Geo. W. Hamlin presented a paper on "A Description of the Baldwin Fairmount Project of Cleveland." A number of questions were asked Mr. Hamlin regarding this project, and considerable discussion followed regarding the velocity of flow in the coagulation basins. Burgess, Hudson, Chester, Lawrence, Dixon and Ellms took part in the discussion.

[31] This Journal, page 737.

At the completion of this discussion, a resolution, in a humorous vein, was offered by H. E. Moses. Mr. Moses' resolution follows:

Whereas, the primary purpose of a filtration plant is to produce a water supply palatable, of good appearance, and bateriologically safe; and,

Whereas, every unit of the plant is presumed to function to that end; and,

Whereas, there has recently been introduced in a certain city's filter plant a device ostensibly intended to produce proper mixture of chemicals and water, said device being known as the "Hydraulic Jump," and,

Whereas, a serious question has arisen as to whether the real effect of said device is only incidently to promote the chemical mixing, but rather to develop a race of *Super-athletic Bacteria* owing to the strenuous exercise to which they are subjected in order to negotiate said hydraulic jump; and,

Whereas, if the latter is true, an additional burden is placed on the filter plant adding to the duties of already overworked operators and chemists;

Therefore, be it resolved that it is the sense of this meeting that the President be instructed to appoint a committee with powers plenary and extraordinary to make a most searching investigation of this matter, and to that end said committee shall be authorized to hold hearings, subpeona witnesses and incur necessary expenditures and that said committee be known as the "Committee to Investigate the Athletic Tendencies of B. Coli Communis."

Mr. Moses' resolution was adopted and he was appointed Chairman of a committee, consisting, in addition to himself, of Hudson and Waring. Much humorous discussion followed the presentation of this resolution.

The next paper presented was written by O. M. Bakke, and read by L. H. Enslow, entitled: "Chloro Tastes and Their Eradication at Dallas, Texas."[32] The paper was read in abstract only, and was discussed by Van Arnum, Harrison, Enslow, Gallaher and Waring.

Announcement was then made regarding the ladies luncheon, dinner-dance and the luncheon to be held at Baldwin Reservoir.

The nominating committee then reported as follows:

To the Central States Section of the American Water Works Association:

Your Committee on Nominations beg leave to report that they recommend to your body the following nominations:

For President: Chester F. Drake, of Pittsburgh.

For Vice-President: Mentor Hetzer, of Moundsville, West Virginia.

For Trustee: Three year term (Vice Joseph C. Beardsley, whose term has expired), C. P. Jaeger of Cleveland, Ohio; for one year term (Vice Mentor Hetzer, who was recommended for Vice President) Clarence W. Wetter, of Tiffin, Ohio.

Respectfully submitted
(Signed) GEORGE C. GENSHEIMER,
D. C. GROBBEL.

[32] This Journal, page 730.

The recommendation of the nominating committee was accepted and the men recommended to fill the various offices were unanimously elected.

The meeting then adjourned.

Wednesday, September 22. After a visit to Fairmount Pumping Station and Baldwin Filtration Plant, the members and guests of the Central States Section assembled in one of the rooms of the Administration Building of the Baldwin Filtration Plant, where the meeting was called to order by President Ellms at 11:30 a.m.

The first paper presented was one by Leo Hudson, on "The Cost of Operating Motor Driven Centrifugal Pumps at McKeesport, Pa." In presenting his paper, Mr. Hudson called attention to the fact that considerable help had been secured in the preparation of this paper from Mr. Richards, and that Mr. Richard's name should appear with his as co-author of the paper.

Further discussion followed the presentation of Mr. Hudson's paper, in which the following took part: Richards, Hudson, Chester, Quayle, Ellms, Lamburger, Van Zandt and Gallaher.

At the conclusion of this discussion, John A. Fulkman presented his paper on "Iron Removal Plant at Selma, Alabama." At the conclusion of Mr. Fulkman's paper, it was announced that the luncheon was getting cold and the discussion was suspended until the afternoon session.

After the luncheon, the convention again assembled in the Administration Building, and, after being called to order by President Ellms, a resolution was offered by the new President, Mr. Drake, of Pittsburgh, reading as follows:

> Be it resolved, that a vote of thanks of the Central States Section of the American Water Works Association, be given to the various contributors to the fund, providing for the entertainment and dinner-dance held in the Rainbow Room of the Hotel Winton, and for the theater party given the ladies; to the Stange Construction Company for the lunch at the Baldwin Filter Plant, and to the Glauber Brass Manufacturing Company for the lunch given to the ladies.

This resolution was unanimously carried.

Discussion then followed regarding Mr. Fulkman's paper, in which Ellms, Enslow and Fulkman took part.

H. E. Moses, then presented his paper—"The Case of the People—Public Health vs. Water."[33] Prior to presenting his report, Mr.

[33] This Journal, page 745.

Moses stated that his committee, which had been appointed to investigate the athletic tendencies of bacteria, had given the matter some attention and proceeded to give a humorous analysis of the situation.

Mr. Moses' paper brought forth considerable discussion, in which the following took part: Leopold, Rice, Waring, Ellms, Gallaher, Dixon, Drake and Hudson.

Mr. Moses presented the closing comments.

A paper, by D. A. Reed, entitled "Iodine as a Food" was read by title only. This method of procedure was adopted owing to the necessity of bringing forth the questions which had been offered for the question box.

At the completion of the reading by title of Mr. Reed's paper, President Ellms relinquished the chair to the new President, Mr. Drake, of Pittsburgh, who requested the secretary to read the first question offered.

The question presented was: "Complaints—How Handled" and the discussion was led by Mr. Gallaher. This question was a part of a larger question of the proper way of running down a claim, and a paper of this subject was read by F. B. Beech and discussed by J. H. Simpson. At the conclusion of this discussion the next question was brought forth as follows:

"What are the results from flat rate charges for municipal fire hydrant rental by a private utility, as compared with rates based on the mileage system?" A paper embodying a discussion of this question was prepared by W. C. Hawley, and read by the Secretary. The question was further discussed by Leo Hudson.

The next question presented was: "What is the consumer's reaction on rates based on a system consisting of a ready to serve charge with a small rental rate, compared with a medium rate, or one based on a rate per thousand gallons, plus a rental for meter?" J. H. Simpson was requested to lead the discussion.

At its conclusion, the subject: "What are the comparative benefits, costs, etc., of the various pipe jointing materials now available?" was presented. The secretary read a statement on this subject, prepared by Chas. L. Fox, of the Pennsylvania Water Company and J. N. Chester presented some further ideas on the subject.

There being no further discussion on this subject, President Drake stated he would entertain a resolution from a visiting member

thanking the local committee for the excellent entertainment had at this convention. Amidst applause J. N. Chester presented such a resolution, which was seconded by Leo Hudson and carried by a rising vote. Mr. Ellms then thanked all who had taken part in the meeting after which the meeting adjourned at 4:30 o'clock.

This adjournment was made necessary by the fact that a number of the delegates had to make train connections and the ending of the meeting precluded the possibility of bringing forth a number of other questions which had been suggested for the question box.

For the entertainment features, a theatre party was provided for the ladies at Keith's Palace in the afternoon and a dinner dance and entertainment for the members and guests in the evening at Hotel Winton on Tuesday, September 21.

On Wednesday, September 22, a luncheon and card party was provided for the ladies, while a clam bake was provided for the men at the Baldwin Filtration Plant. The following is a summary of the attendance at the convention:

Members	54
Associate	26
Corporate	8
Guests	136
Total	224

A. G. LEVY,
Secretary.

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, **12:** 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Proceedings Eighth Texas Water Works Short School. Bulletin No. 1, S. W. Water Works Association, January 18–23, 1926. *Purpose and Outline of Water Works Short School. W. S. Mahlie. 7–8.* The School has been organized for the purpose of teaching the operators the importance of delivering the proper quality of water. The course includes laboratory work and discussions on the various technical phases of plant operation. It is the intention to assist in every way possible to raise the standard of water and sewage treatment. *The Relation of Water to Public Health and the Responsibility of Water Works Operators. Dr. L. H. Martin. 9–15.* The problem of supplying water from the year 3000 B.C. to the present system of New York City is briefly sketched. In Europe during the Middle Ages most of the towns and cities had polluted water supplies, and terrible epidemics of diseases were very common. In the last two hundred years there has been a rapid improvement in water systems all over the civilized world, and diseases caused by using impure water are becoming less common every year. Civic growth and development depends upon the supply and quality of the water furnished. The general public accepts water furnished by such municipalities without hesitation or doubt as to purity. A great responsibility is, therefore, placed upon the municipality and upon the operator engaged in supplying that water. *Water and Milk-Borne Diseases. Dr. L. A. Suggs. 15–18.* The diseases which may be traced to water and milk supplies are outlined. *Raising the Standard of Water Supplies. A. L. Dopmeyer. 18–22.* The economy of having a good water supply may be demonstrated by the remarkable immediate reduction in typhoid fever rate in many of our large cities, immediately upon the substitution of a pure for a polluted water supply. The need at present for raising the general standard of water supplies is more sanitary engineers in the State health departments, and larger appropriations. A routine of activities recommended for effective control of water supplies by State health departments is given. *The Need of Trained Personnel. F. C. Bolton. 22–26.* The sanitary engineer is expected to prevent disease by discovering any possible causes and removing them, or even anticipating them and preventing them from coming into existence. He is responsible for the proper treatment of the water supply that it may be healthful and pure. To maintain the respect and confidence of, and to render efficient and satisfactory service to the public, the water works operator must know all the public knows about his business and much more.

This requires education and training. *Sanitary Protection for Water Supplies and Texas State Board of Health Regulations. Edward D. Hopkins. 26–32.* The sanitary protection of surface water supplies is just the practice of common sense and common cleanliness. With well water or ground waters the first problem is to overcome the mistaken idea that all waters, just because they come from the ground, are pure and wholesome and are good for drinking purposes, if they are palatable. Several typhoid epidemics are recounted, one of them where a saving of $2500 resulted in a loss of $450,000. *The Organization and Operation of the Kansas State Water Laboratory. Ernest Boyce. 32–36.* The laboratory of the State Board of Health in the University of Kansas makes analyses of all water supplies. Under the regulations, all treated surface supplies are given a bacteriological analysis weekly and a field test of the purification works once a year. Only two sets of bacteriological analyses are made of ground waters, per year. One complete chemical analysis is made per year of both surface and ground water supplies. The policy of covering the cost of the laboratory analysis, either by prescribed annual fees or by individual analysis charges, has proven to work very satisfactorily. *Legal Responsibilities in the Production of Water. Gillis A. Johnson. 37–44.* This article discusses the authority and duty of a municipality with regard to its water works system and water supply and the legal consequences which may flow from a breach of duty. Court rulings in a number of cases are given. *Bacteriology of Water. Dr. J. A. Little. 45–51.* By aid of the bacteriologist, the medical men, and trained sanitarians, the mortality rate in the United States is being gradually reduced. Bacteriological methods for examination of water. *Chemical Constituents of Water. W. S. Mahlie. 51–57.* In addition to defining the chemical constituents, this article includes a rapid method of calculating chemicals required to soften water *Milk Testing as a Laboratory Procedure. H. M. Bulbrook. 57–60. Present Tendencies in the Bacteriological Examination. Jack J. Hinman, Jr. 60–71. Summary of The Purpose and Principles of Aeration of Water Supplies. C. A. Emerson, Jr. 78–83.* Aeration of ground waters is usually for chemical oxidation of dissolved iron or manganese or both, and for removal of gases such as carbon dioxide and hydrogen sulfide. Aeration of surface supplies is for elimination of unpleasant tastes and odors due to decomposition of algae. Aeration is accomplished by pumping air into the water or passing water through the atmosphere. *Limitations of Lime Soda-Ash Process of Water Softening Due to Increase in Solubility of Substances Causing Alkalinities in Water When Soda Ash is Added in the Softening Process. Charles P. Hoover. 83–87.* It is not possible to reduce hardness of a hard magnesium water by the lime soda-ash process to two grains per gallon unless water being softened is heated or unless excess lime and soda-ash is added. Excess chemicals increases cost of treatment to between five and six dollars per million gallons, and it introduces into the treated water salts that are conducive to foaming when water is used for boiler feed purposes. *Sedimentation, Coagulation and Coagulant Dosage Control. Lewis I. Birdsall. 87–90. Sterilization of Water. O. M. Bakke. 90–94.* Description of sterilization by use of chlorine. *Effective Chlorination with Minimum Production of Tastes or Odors. Linn H. Enslow. 94–105.* Control of chlorine dosage by testing residual with ortho tolidin is

explained and advocated. *Chemical Constituents of Water as Affecting Industrial Uses. F. B. Porter. 105–109. Water Softening and Railway Water Supplies. C. M. Bardwell. 109–113.* Boiler compounds, soda ash treatment, lime soda process and zeolite softening of water for boiler feed water of railroads is discussed. In many cases annual saving in boiler maintenance is several times the total sum invested in water softening facilities. *The Use of Lime in Water Treatment. Paul C. Laux. 114–116. Gravel and Sand in Filter Beds. Lewis O. Bernhagen. 117–119. Laboratory Control and Operation Records. H. Rosenthal. 119–123. Water Waste Control. A. E. Skinner. 123–124.* A pitometer water waste survey is described. *Beautification of Water Plant and Grounds. J. Z. Martin. 125–129.* A water works plant no matter where it is or what it consists of should at all times be kept clean. Paint is not expensive and it is an important factor in the preservation of buildings and machinery. With a lawn, trees, hardy shrubs, a few beds of flowers, and vines, all well kept, any water works can improve its appearance a thousandfold in a few months. *Policies and Accounting Methods. Jennings M. Moore. 129–132.* Policies and accounting methods of Dallas City Water Works. *Stream Pollution. Edgar Whedbee. 133–138. Sewage Disposal. Paul Hansen. 138–151. Simple Tests for Sewage Plant Control. Frank Bachmann. 151–156. Recent Mechanical Devices for Sewage Treatment. G. L. Fugate. 156–159. Regulations Governing Public Water Supply Classification in Texas and Simple Data for Filter Plant Operators. V. M. Ehlers, E. G. Eggert, Chester Cohen. 160–169.* List of reference books, conversion tables, program of Texas eighth Short School, etc. 169–186.—*A. W. Blohm.*

Fifty-Ninth Annual Report of the Commissioners of Water Works in the City or Erie, Pa., for Year Ending December 31, 1925. 71 pp. Report of operation of water works of Erie, Pa., consisting essentially of tabulated data relating to plant operation, financial dealings, extensions made, etc. Average daily consumption during year was 23,988,971 gallons, an increase of 7.98 per cent, or, on basis of population served of 122,000, 196.6 gallons per capita. Deducting water delivered through meters to industrial concerns, which amounted to 42.4 per cent of total water supplied, per capita consumption was 113.1 gallons per day. An addition to surplus of $250,889.55 was made during the year. Cost of collecting, purifying and pumping the water, including depreciation, averaged $21.057. Number of gallons of water pumped per ton of coal was 258. Average amounts of alum and calcium hypochlorite used during year were 0.17 grains per gallon and 3.9 lbs. per million gallons respectively. Of 306 one-cc. samples of raw water examined for B. coli, 58 gave a positive result, and of 612 samples of filtered water, none gave a positive result. Brief description of plant, which consists of intake in Lake Erie, reservoir, standpipe, filters, and swimming pool, is appended. Schedule of rates is also included.—*R. E. Thompson.*

The Swimming Pool and Disease. J. WALLEN. Iowa Health Bull., **1**: 4, 30–2, October–December, 1925. Report of Committee on Otorhinologic Hygiene of Swimming of the American Medical Association is reproduced and rules for sanitation and safety of swimming pools suggested by that body are given.—*R. E. Thompson.*

Cost of Power from San Francisco's Hetch Hetchy Water Supply. Eng. News-Rec., **96:** 623–4, April 15, 1926. Criticism of program of construction of Hetch Hetchy project by C. E. GRUNSKY, in which suggestion is made that basis of apportionment of costs is such that cost of power produced is made to appear low at the expense of water project, and reply to same by M. M. O'SHAUGHNESSY.—*R. E. Thompson.*

Tunnel Driving and Shaft Sinking in Slaking Rock. Eng. News-Rec., **96:** 573–6, April 8, 1926. Two pressure tunnels and a steel pipe line will carry filtered and chlorinated water from new purification plant of Kansas City, Mo., to high-pressure distributing stations. Main or Missouri Valley tunnel is 7½-feet in diameter, concrete-lined, and 15,500 feet in length, conveying water from purification works in North Kansas City across Missouri Valley and Missouri River to uptake shaft on south bank, where 30 per cent of water is diverted into 54-inch riveted steel pipe line operating on hydraulic gradient and connecting with new East Bottoms pumping station. Remaining 70 per cent of water is carried to downtake shaft, 50 feet west of uptake shaft, connecting with 6-foot diameter concrete-lined pressure tunnel 11,000 feet long discharging by uptake shaft into Turkey Creek reservoir. Construction methods employed, which were complicated by gravel laden with water and rock which slaked like quicklime in air, necessitating lining of bore as rapidly as it was advanced, are described.—*R. E. Thompson.*

Penstock is Self-Supporting Arch in River Crossing. Eng. News-Rec., **96:** 498, March 25, 1926. Brief illustrated description of river crossing in Department of Hautes Alpes, France, hydro-electric project, wherein penstock forms self-supporting arch. Line, which is 8 feet 9¾ inches in diameter, crosses Dirance River in clear span of 223 feet. Plate steel is 0.63 inch in thickness throughout most of arch, increasing to 0.75 inch at abutment. Arch has rise of 13.8 feet, is built to radius of 229.6 feet, and distance between high water level and underside of crown of arch is 311.5 feet.—*R. E. Thompson.*

Weights of Crest and Sluice Gates. DONALD V. C. BIRRELL. Eng. News-Rec., **96:** 499, March 25, 1926. Formula given for estimating weights of structural steel crest gates, together with essential details of various gates, actual and computed weights, and per cent of error. Chart based upon this formula is shown which gives weight in pounds per square foot of gate area for gates of various widths under different average heads.—*R. E. Thompson.*

Plotting a Life Line for Tacoma's Water Supply Conduit. W. A. KUNIGK. Eng. News-Rec., **96:** 562–3, April 8, 1926. Principal water supply of Tacoma, Washington, is derived from Green River and is conveyed to city through a 42-m.g.d. conduit 42.94 miles long constructed in 1913. Conduit consists of 0.58 mile of concrete-lined tunnels and 85-inch concrete pipe, 1.47 miles of riveted steel pipe, 39–46 inches in diameter, and 40.89 miles of continuous wood-stave pipe, 36–60 inches in diameter. In 1920 trouble began to develop in wooden section of line and an investigation of condition of pipe has since been carried out. Test pits were made at intervals of 200–300 feet

up to 5000 feet, and an accurate record was made of conditions observed, from which a flow line profile was plotted showing hydraulic grade and estimated life of each section of pipe. With this diagram as guide a reconstruction program has been planned for each year until line will be completely rebuilt. Certain well-defined causes of early decay of wood staves were apparent, in order of importance as follows: (1) Insufficient pressure to thoroughly saturate staves. (2) Carelessness in backfilling, in not keeping surface soil, decaying roots, and wood or vegetable mold away from pipe. (3) Insufficient depth of backfill. (4) Laying of pipes in made ground, staves being completely decayed in every such instance. (5) Use of sap lumber, which gave rise to blowouts in sections otherwise sound. (6) Laying of pipes in very rich, loamy soil, especially where dry. (7) Proximity of coal veins, acid soil apparently shortening life of staves. Following defects were also noted: (1) The 1⅝-inch staves were too light for 54-and 60-inch pipes. (2) The 60-inch pipes, especially, were found to be flattened as much as 9 inches from backfill of less than 3 feet. (3) Carelessness in not removing all building blocks from under pipe was responsible for bottom buckling. (5) More attention to cradling with proper material would have prevented some broken staves. (6) Failure to drive home some of butt ends of staves gave rise to small leaks.—*R. E. Thompson.*

Tar as a Paint. E. O. Rasser. Kunststoffe, **15**: 131–4, 1925. From Chem. Abst., **20**: 297, January 10, 1926. Tar is of general use where resistance to weathering is important.—*R. E. Thompson.*

River Control at the New St. Louis Water Works. Edward E. Wall. Eng. News-Rec., **96**: 570–2, April 8, 1926. Location selected for new St. Louis water works is on Missouri River at Howard Bend, about 8 miles above St. Charles, Mo., at which point main channel of river will be diverted against south shore, assuring deep water conditions for intake; i.e., instead of extending intake to deep water, the deep water was brought to shore. Control of channel is necessary at all sites on Mississippi and Missouri Rivers. Since construction of existing works at Chain of Rocks in 1888–1892, in excess of $500,000 has been expended on bank revetment to maintain main channel of Mississippi in position where intakes are located. Sample of water taken at Howard Bend in 1923 showed maximum turbidity of 12,000 p.p.m., or about 50 tons of sand and silt per million gallons. River control is effected by means of dikes constructed of willow mattresses of Missouri River type, weighted with stone. Total amount expended on dikes and bank protection up to close of 1925 was $644,900. Cost of 3 dikes now under construction is estimated at $80,000. In all, 23 dikes will be constructed.—*R. E. Thompson.*

Porosity of Reservoir Prevents Water Storage. Eng. News-Rec., **96**: 561, April 8, 1926. Extensive studies have been made of underground water conditions in Malad reservoir near Malad, Idaho, by H. T. Stearns. Construction of dam, which is of multiple-arch type, designed for height of 70 feet and length of 440 feet, was stopped when height of 50 feet had been attained, due to excessive leakage, and work has never been completed. Investigation

indicated that maximum area of leakage is probably not more than 500 feet long and 25 feet wide. Scheme of grouting, which is described briefly, was recommended for remedying the condition.—*R. E. Thompson.*

Rust-Proof Paints—Iron Lacquers—Asphalt Lacquers. E. O. RASSER. Asph. u. Teer Ind. Zeit., **25**: 506–7, 1925. From Chem. Abst., **20**: 297, January 10, 1926. Review of requirements of rust-proof paint with brief discussion of those in use.—*R. E. Thompson.*

Wood-Stave Pipe in Power Project is 16 Feet in Diameter. Eng. News-Rec., **96**: 609, April 15, 1926. Brief illustrated description of creosoted wood-stave pipe, 16 feet in diameter, 1318 feet long, and of 3000 second-feet capacity, connecting two concrete-lined tunnels on Copco hydro-electric plant No. 2, of California Oregon Power Company on Klamath River. Details of cradle and footings are given. Staves are 4 inches thick and 5¾ inches wide and are held in place by ¾-inch steel bands with spacing varying from 3.62 to 3.71 inches. Maximum head on line is 60 feet and operating conditions are such that when pipe is in service it will always be full and under pressure. Steel standpipes at each end of line were provided to prevent occurrence of vacuum and to allow escape of entrained air. Eight pounds of creosote per cubic foot were applied to staves according to specifications of American Wood Preservers' Association.—*R. E. Thompson.*

Some Properties of Ice Crystals. E. K. PLYLER. J. Elisha Mitchell Sci. Soc., **41**: 18, 39–40, 1925. From Chem. Abst., **20**: 18, January 10, 1926. Ice forming between crystals has much higher absorption of infra-red light than the crystals, in both frozen tap water and distilled water. Location of absorption bands in spectra and corresponding transmission are given.—*R. E. Thompson.*

The Effect on the Principal Building Materials of Carbonated and Iron-Bearing Mineral Waters. P. LIÈGEOIS. Ann. soc. geol. Belg., **48B**: 30–2, 1925. From Chem. Abst., **20**: 271, January 20, 1926. Marble is diminished ⅓ of original weight after 10 months immersion. Siliceous-aluminous substances are not appreciably affected, although artificial substances of like character, such as brick, are easily corroded. Mixture of 50 per cent sand and 50 per cent portland cement is completely disintegrated 4 hours after setting. Siliceous substances, such as quartzite, sandstone and eruptive rocks with siliceous base, are not affected.—*R. E. Thompson.*

Army Engineers Recommend Restricting Chicago Diversion. H. J. TAYLOR. Eng. News-Rec., **96**: 576–8, 1926. Report to Congress states that diversion of 4,167 second-feet is sufficient both for navigation requirements and for Chicago sewage disposal. A study to determine a reasonable pollution standard indicated that no nuisance would result if liquid discharged by drainage canal, as evidenced by average of representative samples taken for any 30 consecutive days (*a*) was practically free of solids deposited in 2 hours, and (*b*) contained not less than 3 p.p.m., dissolved O_2 and sufficient to equal or exceed the bio-

chemical O_2 demand of said liquid for 5 days when incubated at 20°. Data given show cost of sewage treatment plants which would be required by Chicago for different rates of flow in the canal, that for 4,167 second-feet being $69,213,520. No method of sewage treatment known to be practicable would maintain purification standard unimpaired with flow of 2,000 second-feet.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

The Classification of (Common) Salt by Its Iodine Content, and the Use of Iodine in Combating Goiter. MICHAEL RÓZSA. Kali, **19:** 313–5, 1925. From Chem. Abst., **20:** 239, January 20, 1926. Statistics of distribution of goiter in Austria and Hungary, and of corresponding concentrations of iodine in water supply, salt used, and milk supply, are given. Legal requirement of 3 mgm. of potassium iodide per kilogram of salt for domestic consumption is recommended.—*R. E. Thompson.*

The Biological Factors Involved in the Destruction of River-Fisheries by Pollution Due to Lead Mining. K. E. CARPENTER. J. Appl. Biol., **12:** 1–13, 1925. From Chem. Absts., **20:** 243, January 20, 1926. Continuation of studies previously reported (cf. C. A. **18:** 3233). Present article included experiments on toxicity of lead compounds to various fresh-water fishes and analyses of river waters polluted by lead mining industry.—*R. E. Thompson.*

Electrometric Studies of the Precipitation of Hydroxides. HUBERT THOMAS STANLEY BRITTON. J. Chem. Soc., **127:** 2110–59, 1925. From Chem. Abst., **20:** 26, January 10, 1926. Dilute alkali hydroxide was added gradually to solutions of metallic salts and H-ion concentrations at which hydroxides were precipitated were measured by means of H-electrode. Magnesium hydroxide was precipitated at pH 10.4 manganous hydroxide at pH 8.4, and ferrous hydroxide at pH 5.5. In every case precipitate contained appreciable amount of anion of salt used. The pH values are practically independent of nature of anion present and of precipitant, and are affected but slightly by changes in concentration of metal salts in dilute solutions which have to be attained before hydroxide can precipitate. Aluminum hydroxide begins to precipitate at pH 4.1. Basic salt, rather than pure hydroxide is precipitated. Aluminum hydroxide is definitely amphoteric, uniting with one molecule of sodium hydroxide, for example, to form $NaAlO_2$.—*R. E. Thompson.*

The Purification of Water Supplies on Field Service: A Retrospect. WM. HORROCKS. J. Roy. Army Med. Corps, **45:** 167–89, 1925. From Chem. Abst., **20:** 250, January 20, 1926. Historical account of Horrocks's and similar tests and of methods of chlorination employed in field during war.—*R. E. Thompson.*

Boiler Feed Water Purification. A. S. BEHRMAN. Mech. Eng., **47:** 909–10, 1925. From Chem. Abst., **20:** 252, January 20, 1926. Discussion of lime-soda and zeolite softening. Latter increases tendency of boilers to foam and prime. There appears to be relation between excess soda and embrittlement. Excess soda ash treatment within boiler is used to prevent scale of calcium

sulphate, but cases are known where scale has formed with such treatment. Hot process of lime treatment is more effective in removing calcium carbonate than cold, owing to formation of colloidal calcium carbonate in latter.—*R. E. Thompson.*

The Mineral Waters of Saint-Gervais-les Bains and le Fayet (Haute-Savoie). D'Arsonval, F. Bordas and F. Touplain. Ann. fals., **18:** 454–60, 1925. From Chem. Abst., **20:** 250, January 20, 1926. Description of the two springs, surrounding geologic formation, and chemical composition of water.—*R. E. Thompson.*

The Transparence of Natural Waters to Ultra-Violet Rays. J. Duclaux and P. Jeantet. Compt. rend., **181:** 630–1, 1925. From Chem. Abst., **20:** 251, January 20, 1926. Salts in amounts commonly found do not diminish transparence of natural waters to ultra-violet rays. Three parts per million of ammonia will diminish transparency to rays above 2000 A.U. Turbid waters are almost opaque to such rays. One part per million of nitrates or nitrites gives characteristic absorption at 2300 A.U.—*R. E. Thompson.*

Investigations of Ice. Örs v. Hubay. Z. Nahr. Genussm., **49:** 370–3, 1925. From Chem. Abst., **20:** 251, January 20, 1926. Turbid portions of ice were found to contain more impurities than clear portions, ratio of the averages of 20 samples being: residue on evaporation 3.08:1; chlorides 2.54:1; oxidizability 1.23:1; bacteria 1.43:1.—*R. E. Thompson.*

Pulverized Fuel for Boilers and Furnaces. W. R. Chapman. Fuel in Science & Practice, **4:** 396–400, 420–4, 1925; cf. C.A. **19:** 3361. From Chem. Abst., **20:** 272, January 20, 1926. Discussion of proper lining of combustion chamber, disposal of ash, suitability of different types of fuels, efficiency of pulverized coal, and comparison of other methods of firing. Ibid. 486–92. General discussion of value of pulverized fuel under various conditions and results obtainable in comparison with gas.—*R. E. Thompson.*

City of Toronto Report on Proposed Extensions to the Water Works System. H. G. Acres and William Gore. May 15, 1926. To meet the requirements of unfailing and dependable service the engineers' choice of a water supply for the City of Toronto falls on Lake Ontario. Victoria Park has been selected as the most suitable of all intake locations. The scheme for the extensions includes: (*a*) At Victoria Park an intake tunnel 10 feet in diameter, constructed in shale, and extending from the shore out underneath the lake bottom a distance of 3300 feet, into 30 feet depth of water, and terminating in a submerged tunnel shaft. This tunnel will have a maximum capacity of 300,000,000 gallons per day; (*b*) from end of the tunnel shaft provision to be made for the laying of three steel intake pipes, one to be laid now, this being 8 feet in diameter, 4,250 feet in length and terminating in 50 feet depth of water. The initially installed pipe will have a capacity of 125,000,000 g.p.d.; (*c*) at Victoria Park low lift pumping station, coagulating basins, filters, reservoir, general offices and laboratory, with provision for treating 100,000,000 g.p.d.,

high lift pumping station; (*d*) from Victoria Park a concrete lined filtered water supply tunnel 7 feet in diameter and 30,500 feet in length to existing main pumping station at John Street; (*e*) at John Street pumping station a low lift booster pump installation; (*f*) a concrete lined filtered water tunnel six feet in diameter, 19,000 feet long from John Street station to a high lift pumping station to supply the western and north-western area of the city; (*g*) a 42-inch main to connect District No. 2, and 24-inch distribution main to District No. 1; (*h*) a 50,000,000 gallon covered reinforced concrete storage reservoir; (*i*) an ornamental 300,000 gallon elevated tank. The net total cost of the work is estimated at $14,317,000, and will require three and one-half years to complete construction. The possibility of obtaining water from "Ridge Lakes," from artesian wells, or from the upper basin of the Humber River or the Don River is dismissed on the ground of inadequacy. The Lake Simcoe scheme is dismissed because of inaccessibility, as the remotely located intake and the intervening 45 miles of tunnel and surface conduit constitute a hazard to continuous and effective service.—*A. W. Blohm.*

Study of the Movement of a Bubble of Air Rising through Water. OTOGORO MIYAGI. Technology Reports of Tohoku (Tokyo?) Imperial University, **4**: 3; Le Genie Civil, **87**: 571, Dec. 26, 1925.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Fuel Economies of the Service of Water Supply and Sanitation of Paris. "A. M.," Le Genie Civil, **88**: 210–212, February 26, 1926. A review of an article by H. GIRAUD, Journal officiel, January, 1926. One million francs was saved in 1924 by means of instruction by demonstrations and printed matter, by premium to firemen and by improvements and studies on the selection of coals.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The problem of domestic wastes. FETTWEIS. La Technique Sanitaire, 20, 289 (November 1925). Belgian practice.—*Jack J. Hinman, Jr.*

Removal, treatment and utilization of domestic wastes in France. FREMOND. La Technique Sanitaire, 20, 272–285, (November, 1925).—*Jack J. Hinman, Jr.*

Domestic Wastes, collection, removal, utilization and destruction. PIOT. La Technique Sanitaire, 20, 285 (November, 1925). Swiss practice.—*Jack J. Hinman, Jr.*

Recent Methods of Differentiating Lactose-Fermenting Organisms as Applied to Indian Conditions. II. J. CUNNINGHAM and T. N. S. RAGHAVACHARI. Ind. J. Med. Res., **14**: 41–5, July 1926. The proportion of high and low ratio organisms of colon group present in soil and in filtered waters was studied. Percentage of low ratio (methyl red positive, Voges-Proskauer negative) types found in soil varied from 38.8 per cent in samples collected at surface to 6.1 per cent in samples from 6 inches below surface. Results of similar examinations of filtered waters (classified according to type of plant), and of waters

from infiltration galleries and wells were as follows: slow sand filtered, 58.4; mechanical filtered, 71.6; and infiltrated, 72.6 per cent. The raw water for the slow sand and mechanical plants contained average of 78.9 and 83.3 per cent respectively, of low ratio organisms. Filtration apparently effects some reduction in the proportion of low to high ratio organisms present, the slow sand system being the more effective in this regard.—*R. E. Thompson.*

Flood Probability. P. T. SIMONS. Eng. News-Rec., **96**: 704, April 29, 1926. Forestation as means of flood protection is considered to be a fallacy. Three factors determining flood probability are: (1) precipitation, (2) temperature (in northern latitudes), and (3) concentration time.—*R. E. Thompson.*

Economical concreting plant for tank construction. Eng. News-Rec., **96**: 808–10, May 20, 1926. Concreting plant, employing industrial track plan, used during construction of settling, mixing and coagulation basins of new Kansas City, Mo., water works is described and illustrated. The 11 structures, which cover 14 acres, required 35,000 cubic yards of concrete.—*R. E. Thompson.*

Operation of River Regulating Reservoirs. MELVIN D. CASLER. Eng. News-Rec., **96**: 812–6, May 20, 1926. Method of studying possibilities of storage reservoirs by use of mass curves of cumulative flow is discussed in some detail.—*R. E. Thompson.*

Laboratory Reaction Apparatus Helps Operate Filters. CHAS. H. SPALDING. News-Rec., **96**: 644–5, 1926. Results of laboratory experiments on coagulation carried out at Oklahoma City are described and graphically illustrated. When employing $FeSO_4$ and lime, with 30 min. reaction period, it was found that addition of former just prior to latter gave the greatest clarification, while when $FeSO_4$ was added after the lime it was found that the softening reaction should be allowed to proceed several minutes before adding coagulant. If interval is increased beyond 5 minutes the reaction period for the $FeSO_4$ is correspondingly reduced with consequent loss in coagulant value. When employing alum and lime, addition of coagulant after lime was most effective. Interval in this case may be 10 minutes. When optimum coagulation is obtained long subsidence has little advantage. In laboratory experiments $FeSO_4$ was found to be more effective and economical than alum, but in practice it is found advisable to use alum also, $FeSO_4$ alone failing to give as clear an effluent, apparently owing to a difference in floc. The experiments were carried out in an apparatus consisting of 6 precipitation jars in a row beneath a counter shaft carrying a paddle for each jar. Power is furnished by a small motor and each paddle can be operated independently of the others.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Tunnel Taps Mystic Lake Below Water Surface. Eng. News-Rec., **96**: 642–3, April 22, 1926. Construction of tunnel for drawing water from Mystic Lake, 43 feet below low water level, in hydro-electric project of Montana Power Co., described briefly and illustrated. A main tunnel and branch were

driven, former being used to draw down lake level to enable construction of head-works on branch. Main charge of 2¾ tons of 90 per cent dynamite and 5 auxiliary charges of 300 pounds each were employed in final blast which opened main tunnel to lake.—*R. E. Thompson.*

New Rust-Preventive Paint. HANS REBS. Farbe und Lacke 1925, No. 11, 124. From Chem. Abst., **20:** 298, January 20, 1926. Rebs disputes claim that Pb_2O, used as pigment with linseed oil, gives up its oxygen to the oil and deposits film of metallic lead, and other claims made for this pigment. Reply by W. PFLÜGER is appended.—*R. E. Thompson.*

Two Improved Methods of Electric Welding. Eng. News-Rec., **96:** 647, April 22, 1926. Two new methods of electric welding are described, both of which employ hydrogen or other gas as means of excluding air from region of weld. One method developed by I. LANGMUIR involves passing a stream of hydrogen between electrodes which carry the welding arc. Heat of arc breaks up hydrogen molecules into atoms which recombine a short distance in front of arc, producing flame which liberates 50 per cent more heat than oxy-hydrogen flame. Welded pieces have been twisted and bent double without injury. In other method, developed by P. ALEXANDER, hydrogen in molecular form is used as flux and as shield against atmospheric gases. Metal deposited in this process has not only high ductility but also higher elastic limit than normal metal. Other gases have also been experimented with.—*R. E. Thompson.*

Grouting Marston Lake Earth Dike to Stop Seepage. BURTON LOWTHER. Eng. News-Rec., **96:** 650, April 22, 1926. Observations on seepage through earth embankment impounding water in Marston Lake of Denver, Colo., water works, and measures adopted for remedying the condition, described briefly. No trouble is anticipated in filling lake to 6000 m.g.—*R. E. Thompson.*

New Bedford Accounts for 90 per cent of Water. Eng. News-Rec., **96:** 653, April 22, 1926. With allowance of 3 per cent for slip of meters, all but 10 per cent of water supplied in 1925 in New Bedford, Mass., was accounted for. Amount supplied was 65 gallons per capita daily. The 58 gallons accounted for was divided equally between manufacturing and all other uses. In 1924 water accounted for was 84 per cent.—*R. E. Thompson.*

Providence Spending $21,000,000. Eng. News-Rec., **96:** 866, May 27, 1926. About $18,000,000 has been expended on the $21,000,000 Scituate water supply project of Providence. The 37,000-m.g. Scituate reservoir has filled to 60 per cent of its capacity. The 7-mile aqueduct, including 3½ miles of tunnel, is practically completed. Part of rapid sand filtration plant will be put in commission this summer and remainder by end of year. Plant, which includes influent and effluent aëration units and large open coagulation basins, is of 50-m.g.d. capacity. Additions to filters and effluent reservoir will extend it to ultimate capacity of 100 m.g.d. Project will probably be completed in 1928.—*R. E. Thompson.*

Catskill System Essentially Completed. Eng. News-Rec., **96:** 866, May 27, 1926. Stream-control conduit through Gilboa dam is being closed. The 20,000-m.g. Schoharie reservoir formed by this dam will be put in service this summer, making essential completion of Catskill system. Reservoir will regulate flow of Schoharie Creek through 600-m.g.d. Shandaken tunnel completed in 1924.—*R. E. Thompson.*

New Jersey Metropolitan District. Eng. News-Rec., **96:** May 27, 1926. Dam of 27,000-m.g. Wanaque reservoir of North Jersey Water District is 75 per cent completed and 105-m.g.d. Great Notch tunnel is practically finished.—*R. E. Thompson.*

Rochester Surveys. Eng. News-Rec., **96:** 866, May 27, 1926. Surveys of various possible sources of supply are being made to find best one for at least doubling present capacity of 30 m.g.d.—*R. E. Thompson.*

Buffalo Filters Nearly Completed. Eng. News-Rec., **96:** 866, May 27, 1926. Treatment plant (160-m.g.d.) and low-lift pumping station at Buffalo are nearly completed.—*R. E. Thompson.*

Philadelphia Improving Existing Works. Eng. News-Rec., **96:** 866, May 27, 1926. Torresdale pre-filters are being rebuilt and new intake and additional pumping units are being constructed. New Fairmont dam on Schuylkill River is nearly completed.—*R. E. Thompson.*

Baltimore Making Extensive Improvements. Eng. News-Rec., **96:** 866, May 27, 1926. New 112-m.g.d. wood-slat-bottom filter plant near old 128-m.g.d. plant will soon be completed, at cost of $2,780,000. Surveys are being made on Prettyboy impounding project; a 2,000-m.g. reservoir formed by dam 120-feet high with 200-foot ogee spillway.—*R. E. Thompson.*

Additional Conduit and Filters for Washington. Eng. News-Rec., **96:** 866, May 27, 1926. Washington's new 100-m.g.d. conduit is in commission. Two high-service reservoirs and first high-service pipe line are completed, while second and third pipe lines are over 50 per cent finished. New 80-m.g.d. filter plant will be completed in July, 1927.—*R. E. Thompson.*

Atlanta Intake and Mixing Basin. Eng. News-Rec., **96:** 866, May 27, 1926. Atlanta, Ga., is building a 60-inch intake conduit at Chattahoochee River pumping station and a $140,000 concrete mixing basin and brick chemical house at the filtration plant.—*R. E. Thompson.*

Activities at One Florida City. Eng. News-Rec., **96:** 866, May 27, 1926. Tampa, Fla., recently put in use a 15-m.g.d. pumping station 6 miles distant on Hillsboro River.—*R. E. Thompson.*

Additional Indianapolis Filter in Use. Eng. News-Rec., **96:** 866, May 27, 1926. New 12-m.g.d. filter plant and two 6-m.g.d. motor-driven centrifugal

pumps for high service were recently put into service by Indianapolis Water Co.—*R. E. Thompson.*

Knoxville Additions Under Way. Eng. News-Rec., **96:** 866, May 27, 1926. Major contracts have been let for new $1,250,000 water works of Knoxville, Tenn., which comprises a short tunnel and intake, pumping station, 15-m.g.d. filters, and 10-m.g.d. reinforced concrete box-type reservoir. The two 15-m.g.d. high-lift pumps are of steam-turbine centrifugal type operating under 350-foot head, with turbines also driving electric generators supplying two 18-m.g.d. low-lift motor-driven centrifugals under 50-foot head. High-lift units have guaranteed duty of 200 m. foot-pounds per 1000 pounds of steam. Pumping equipment contract is $120,000. Two 500-h.p. boilers with stokers will furnish steam at 300 lb. pressure and 200 deg. superheat.—*R. E. Thompson.*

Progress at Nashville. Eng. News-Rec., **96:** 866, May 27, 1926. Nashville, Tenn., is spending $2,000,000 for improvements which include 2-m.g. high-service reservoir, 2-m.g.d. high-service booster station, boiler plant, and main extensions. Contracts will be let before January 1 for a 28-m.g.d. filter plant and for covering the 52-m.g. Kirkpatrick Hill reservoir.—*R. E. Thompson.*

Detroit Adds 300 Miles of Pipe. Eng. News-Rec., **96:** 867, May 27, 1926. Detroit will add 300 miles of pipe to distribution system this year. New supply project which will be undertaken soon includes intake in Detroit River, 10 miles of 12 and 14-foot tunnel, low-lift pumping station, filtration plant, and 220-m.g.d. distribution pumping station.—*R. E. Thompson.*

More Reservoirs for Portland, Ore. Eng. News-Rec., **96:** 867, May 27, 1926. First 100-m.g. unit of 500-m.g. storage near city will be started in near future. Contract will soon be let for Bear Creek dam on Bull Run River and for clearing site of the 11,000-m.g. reservoir.—*R. E. Thompson.*

World's Largest Pumping Station. Eng. News-Rec., **96:** 867, May 27, 1926. Work on 300-m.g.d. Western Avenue station, Chicago, is about 60 per cent completed. It is expected that it will be in use in summer of 1927. Other large projects well under way are Chicago Avenue tunnel, which is 4,900-foot extension of 16-foot tunnel from Two-Mile Crib to proposed crib opposite Carter Harrison Crib and 11,000 feet of 13-foot tunnel to Chicago Avenue station. Progress in 10-year program of universal metering has been slow due to labor conditions.—*R. E. Thompson.*

Completing St. Paul's Five-Year Program. Eng. News-Rec., **96:** 867, May 27, 1926. The 90-inch concrete conduit, 23,400 feet long, between Vadnais Lake and the 42-m.g.d. filtration plant, completes the $5,500,000 program started in 1920, consisting of filters, 16- and 18-m.g. reservoirs, pumping station for distribution and one to raise Mississippi River to chain of small lakes, and 60-inch conduit 43,500 feet long—8000 feet of steel and 35,500 feet of concrete.—*R. E. Thompson.*

St. Louis Howard Bend Plant. Eng. News-Rec., **96**: 867, May 27, 1926. The $1,060,000 contract for intake and engine pits will be finished in near future. The $1,160,000 Stacy reservoir will be completed in about one year; also the $715,000 filter plant contract. Contracts will be let for 3 low-service steam-turbine-driven centrifugals and 2 high-service centrifugals under $650,000 appropriation, and plans are under way for settling basins, grit chamber, and mixing chamber costing $1,000,000.—*R. E. Thompson.*

Tacoma Spending $1,000,000. Eng. News-Rec., **96**: 867, May 27, 1926. The 1926 program of Tacoma, Wash., involves an expenditure of $1,000,000 and includes 25-m.g. reservoir, 5 miles from city, 1-m.g. standpipe in city, 34- and 36-inch pipe line connecting reservoir and standpipe, 30-inch conduit from reservoir to Puget Sound, 10-m.g.d. electrically operated pumping plant, and reinforcement of distribution system.—*R. E. Thompson.*

Completion Percentages at Kansas City. Eng. News-Rec., **96**: 867, May 27, 1926. Percentages of completion of main contracts for new Kannsas City water works are: Missouri Valley $1,360,000 tunnel, 21 per cent; Turkey Creek $850,000 tunnel, 70; East Bottoms $710,000 station, 90; $550,000 steel pipe lines, 81; $2,050,000 settling basins, 49; $1,300,000 filtration plant, 58; $250,000 intake, 68; $280,000 valves and cast-iron pipe, 90; average, 55. It is expected that work will be completed early in 1928.—*R. E. Thompson.*

Garza Dam at Dallas Nearly Done. Eng. News-Rec., **96**: 867, May 27, 1926. Hydraulic-fill dam on Elm Fork of Trinity River, 80 feet high and 2 miles long, of which 3500 feet is across main valley, is being constructed at cost of $5,000,000, to impound 63,000 m.g. from drainage area of 1,110 square miles. Service spillway is concrete, ogee type, 560 feet long, and will discharge 78,000 second-feet with emergency spillway capacity of 135,000 second-feet. Embankment contains 2,000,000 cubic yards. Construction started October 3, 1924, and will probably be completed September 1, 1926.—*R. E. Thompson.*

Completed and Projected Work at Denver. Eng. News-Rec., **96**: 867, May 27, 1926. Denver, Colorado, has just completed $7,500,000 three-year program involving: 70-m.g.d. filter plant and 23 miles of conduits; 100 miles of distributing mains; and 5 centrifugal pumps, aggregating 49 m.g.d. capacity, in 3 stations. Survey and budget of $7,500,000 for next 6 years' requirements, under compilation, includes: 24 miles of conduit; recostruction of Lake Cheesman outlet system, Kassler slow sand filters and Capitol Hill pumping station and reservoirs; and $2,250,000 distribution system extensions. Consummation of plans for use of Fraser River water to be brought through Moffat tunnel and for additional storage on South Platte River has been postponed by resignation of majority of water board because of differences over policies.—*R. E. Thompson.*

An Improved Electric Flow Meter. THOMAS R. HARRISON. Paper by The Brown Instrument Company. This paper, by the director of research of the Brown Instrument Company, describes the construction and operation of the

new electric flow meter which has been placed on the market by this company.—*A. W. Blohm.*

Determination of Minute Amounts of Phenols in Polluted Natural Waters. LOREN R. VORCE. Ind. and Eng. Chem., **77**: 7, 751, July, 1925. The method employed to determine the amount of phenols present in the water of the Cuyahoga River is briefly: To 2 or 3 litres of sample in flask add 2 to 4 grams solid caustic soda, shake frequently until precipitated bases and coagulated albuminous matter have separated. Filter. To filtrate add 25 cc. H_2O_2, shake thoroughly and allow to stand over night. Fit flask with constant-level delivery tube. Place 20 gr. solid sodium hydroxide in 15 cm. evaporating dish, and, for 1 litre sample, support on stand over Bunsen burner. Keep contents just below boiling point and evaporate to 200 cc. Transfer to 750 cc. Kjeldahl flask and chill. Add 45 gr. crystallized citric acid and distil and make up to 500 cc. with distilled water. This solution contains all but traces of phenol in original sample. Amount of phenols may be determined by comparison with color standard tubes prepared with Folin and Denis phenol reagent and saturated sodium carbonate solution.—*A. W. Blohm.*

NEW BOOKS

Hydraulics. JOSEPH N. LE CONTE, Professor of Engineering Mechanics University of California, McGraw Hill Book Co., Inc., 1926. This is a work which presents the theoretical principles of hydraulics. The reader is carried step by step by means of mathematics and mechanics from simple hydraulic relations to the solution of some rather complex problems dealing with the movement of water and water machinery.

The author states that the book is "for the student." He has developed, however, the solution of so many interesting and important problems from the familiar basic hydraulic principles that the engineer who ordinarily uses empirical rules and diagrams will find much of value in the work.

The first section of the book concerns the mechanics of fluids at rest, the second section treats of the motion of liquids, and the last section studies various types of hydraulic machinery.

It is believed that the second section, dealing with hydraulics proper, will prove of most interest to the average engineer. Here the author develops Bernoulli's Theorem from the power in a stream of water due to its pressure its position and its kinetic energy and works out many problems by its use. Starting with the formula for free discharge, $v = \sqrt{2gh}$ he discusses the properties of coefficients for various conditions of flow through orifices, and then shows how the velocity head relationship has been developed into several of the well known weir formulas. Under the heading of Restrained Discharge, he studies the flow of water in pipes, nozzles and conduits of varying sections, developing the Weisbach and the familiar $v = C\sqrt{rs}$ Chezy formula. In the study of penstocks and surge tanks with variable flow of water, he presents problems and gives solutions which should prove of value to those engineers not familiar with this type of mathematics. At the end of the section, a brief

description of the flow of water in open channels is given, and the section is concluded with a chapter on the measurement of water.

In the last section of the book, Professor Le Conte discusses jet and full running turbines, and centrifugal and jet pumps, only the hydraulic theory and conditions for maximum efficiency and not the machine design being given.

The subject matter of this book is well arranged and is easy to follow. While some of the mathematics are involved, each problem is developed in such a way that the hydraulic theory presented can be understood, after which the mathematical solution can be taken for granted as being correct. While Professor Le Conte's "Hydraulics" cannot be used as a general reference work for the ordinary practicing engineer, nevertheless, it is believed that its field is more than that of the student alone.—*G. J. Requardt.*

Electro-pompes automatiques de petit et moyenne puissances pour distributions domestiques et industrielles. RÉNÉ VAN MUYDEN and LÉON VODOT. Libraries Hachette et Dunod, Paris, 4to, 104 pages, 149 figs., Noted in Le Genie Civil, **88**: 124, January 30, 1926.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

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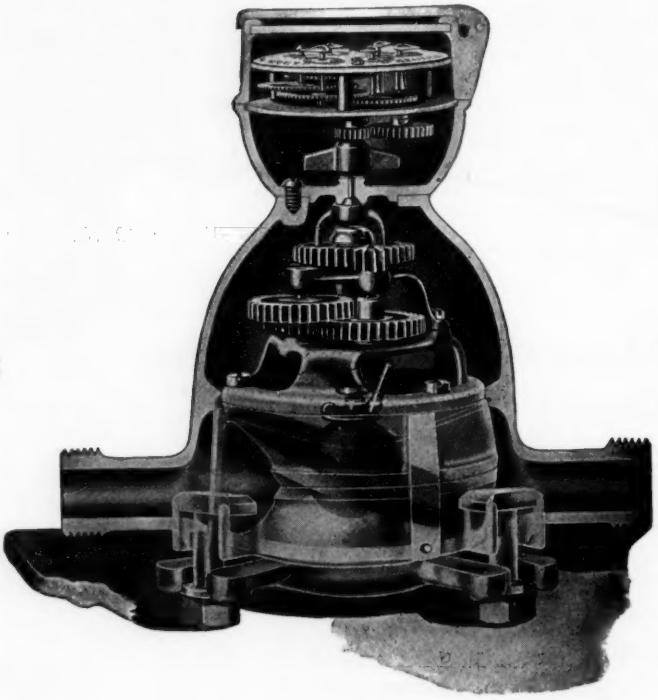

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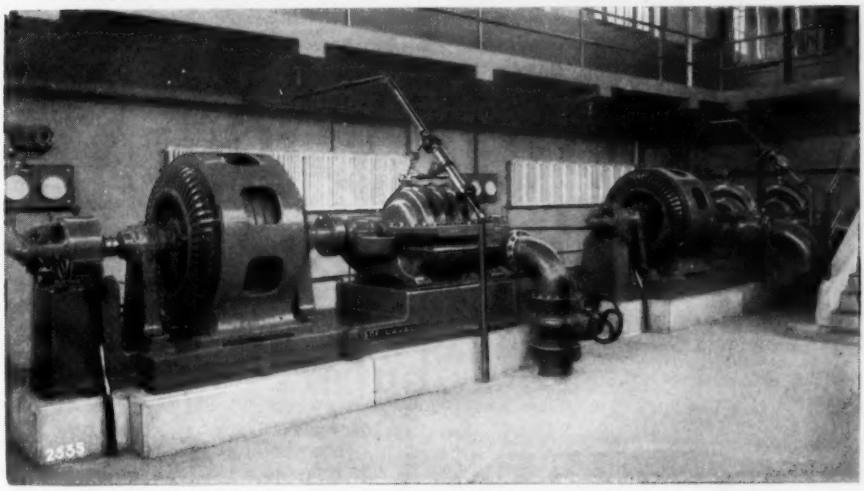

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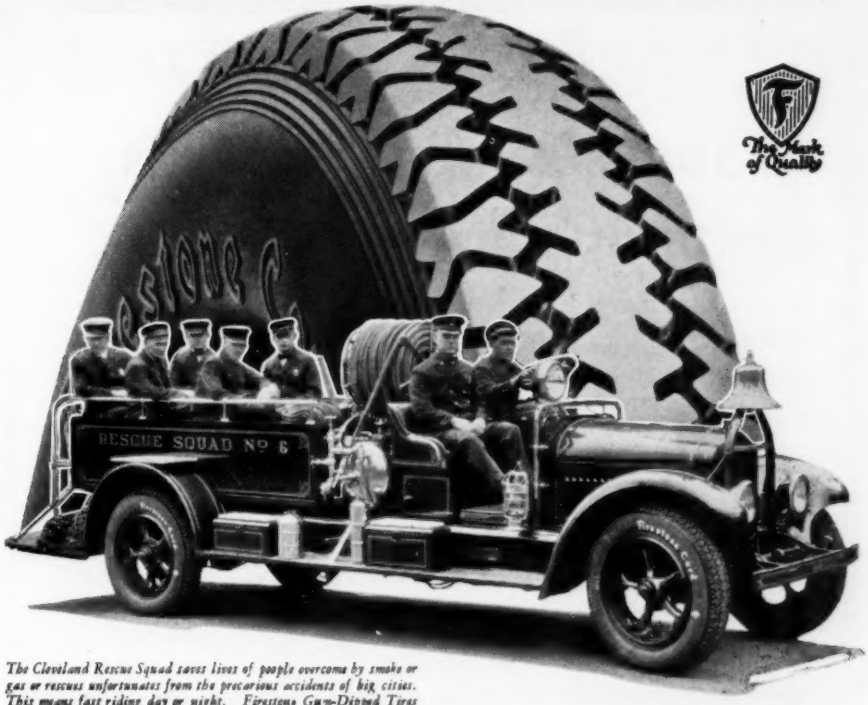

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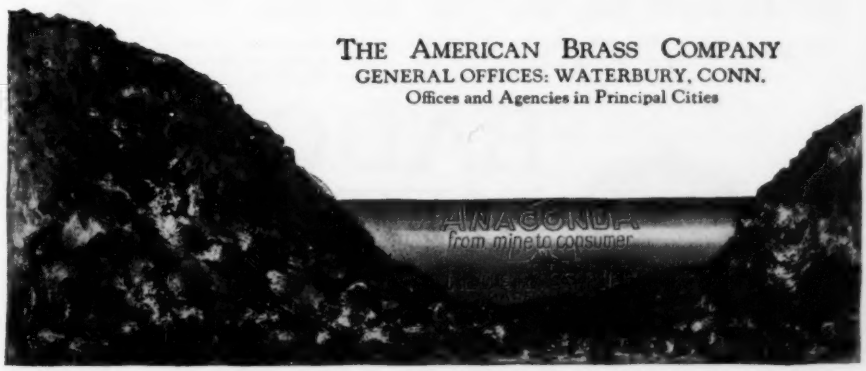

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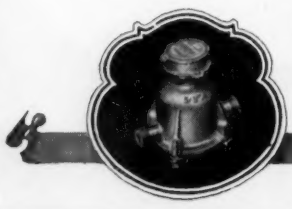

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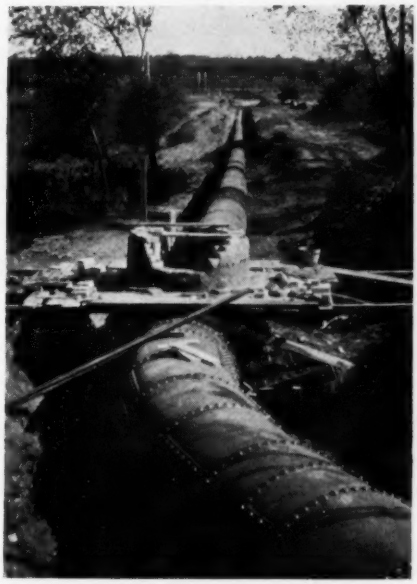

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Nearing the North Shore. Showing the dredger, pile drivers and cradle.

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Under the water pressure test only four small leaks developed and these were easily recaulked by a diver. The water was then pumped out and an air pressure of 125 lbs. per square inch put on the line and maintained without evidence of leakage anywhere.

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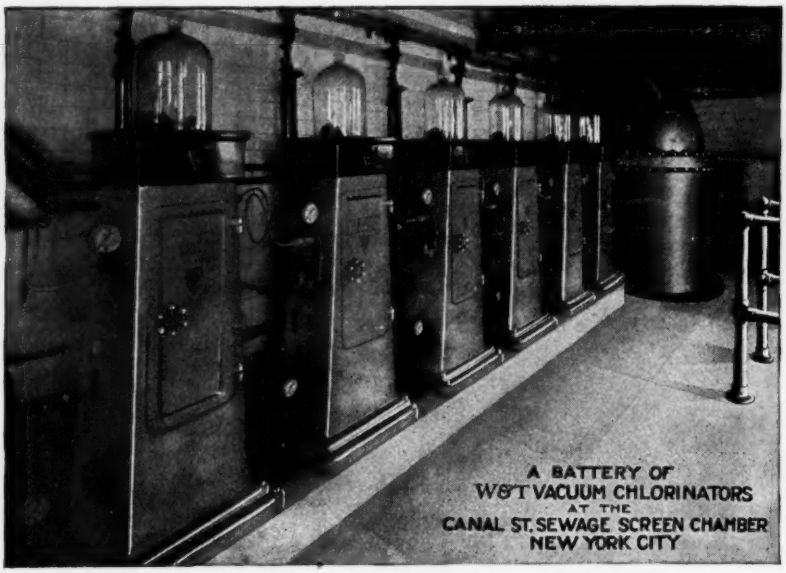

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The first vacuum chlorinator is still in operation.

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Indicates the true chlorine flow —average error negligible.

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No diaphragm valves on the chlorine supply.

LEAK PROOF
Any leaks would be *into* the apparatus — because of the vacuum.

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Silver — platinum — glass — hard rubber — nothing else comes in contact with wet chlorine.

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The glass bell jar lets you see what is going on.

LOW UP-KEEP
Averages less than 1% per year.

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The vacuum completely empties the chlorine cylinders.

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"The only safe water is a sterilized water"

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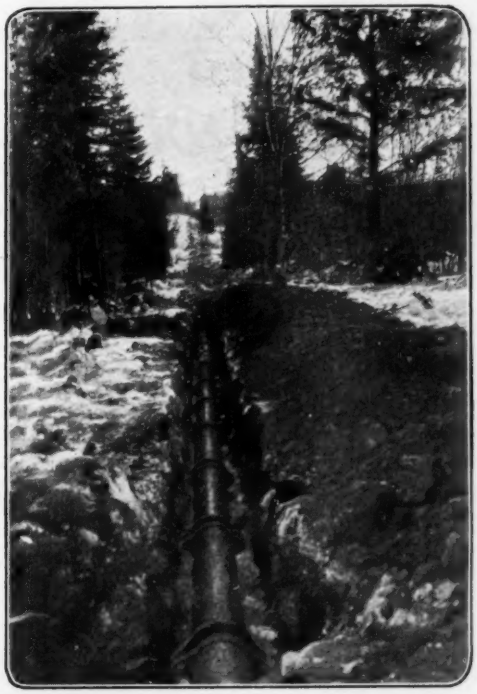

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No bell holes to dig. No joints to calk.
Wrenches the only tools.

For tight, flexible, dependable water supply and fire protection lines address nearest office

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SERVICE PIPE

Does not depend on water pressure to hold it in shape.

Is not injured by careless handling or back-filling.

Uses standard fittings.

Sixty years use proves it rustless.

Has no harmful effect on any water.

Now standard in dozens of the most progressive cities and towns.

Inexpensive.

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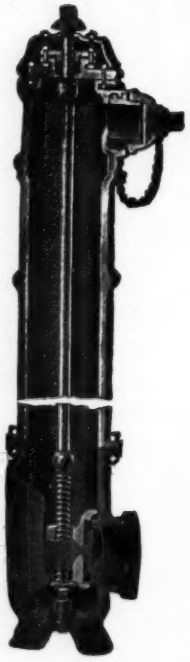

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FROZEN!—but not damaged

Here is an actual photograph of a LAMBERT Frost-Proof Meter which has been frozen to an extent that would put the ordinary meter completely out of commission.

This is made possible by a patented, non-corrosive yielding bolt device which allows the upper and lower casing, disc chamber and gear train to part without damaging the meter in any way. Five minutes' labor the only repair cost.

The expense and annoyance from frozen water meters can be eliminated for all time through the installation of the LAMBERT Frost-proof.

It has been proved that the LAMBERT is the easiest water meter to take apart and put together again as well as the simplest, most reliable and accurate.

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Worthington Water Meters

The Worthington meter line is complete. It includes a meter for every possible service and condition.

Disk Meters—both frost-proof and for warm climates

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Pumps, steam and power, reciprocating and centrifugal

Pumping Engines, horizontal cross-compound and vertical triple expansion, crank and fly-wheel and direct-acting

Condensing Apparatus, surface, jet, baro metric

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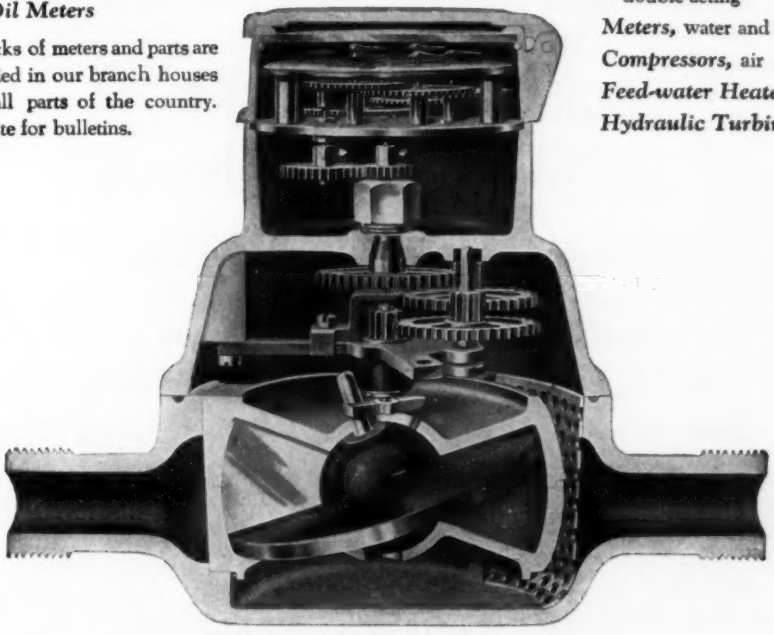

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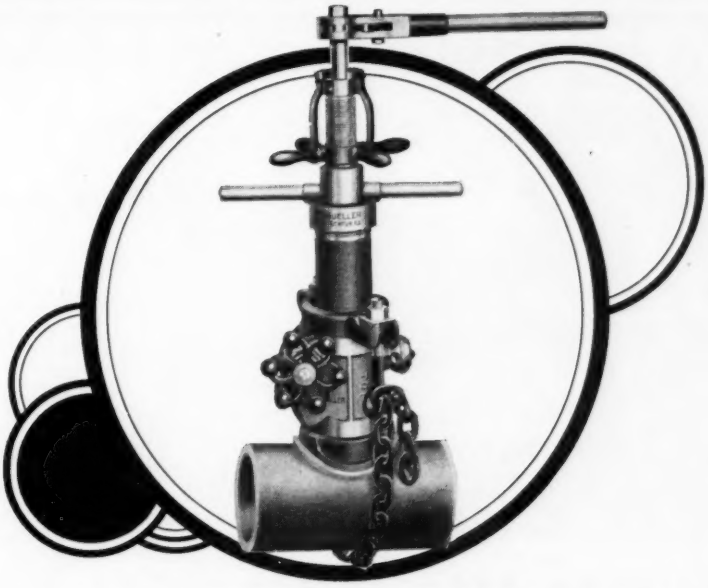

Better, quicker tapping

with the *improved* Mueller Tapping Machine *B*

Mueller engineers have designed ***new*** efficiency in the Mueller Water Tapping Machine "B," shown above. Embodying all the recent Mueller improvements, this machine sums up all that is best in tapping machine construction. The ease and speed with which it taps a main and inserts a corporation stop is nothing short of a revelation to those observing its operation for the first time.

You cannot afford to do your tapping with a machine of less efficiency. The improvements in the Mueller "B" will speed up your work. You can effect greater savings in time and labor. Greater economy in tapping costs will soon pay for the cost of the machine.

The Mueller Tapping Machine "B" makes taps and inserts stops from one-half to one inch in pipe under pressure. It makes taps alone from one-half to two inches in open or dry pipe. When used with Mueller Corporation Stops, with the superior Mueller thread, a permanent non-leaking joint is assured.

We will make a liberal trade-in allowance on your old Mueller model. Write for details today.

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Will McWane Joints Hold?

The above pictures of an 8-inch McWane Precalked Joint cast iron water main before and after the recent Florida hurricane are an answer to that question.

They hold!

For tight joints, for lower cost and easier, quicker pipe-laying, address:

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McWANE PRECALKED JOINT CAST IRON PIPE

Sizes: 1¼—through 8 inches.

Standard lengths.
Precalked Joint Fittings.

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Patent Automatic Cushioned Controlling Altitude Valves

We have enlightened many a water user in municipalities, in industrial plants and on railroads, as to the **adaptability** of these Golden-Anderson Valves, and as to their function of SAVING, and of eliminating troubles.

For automatically maintaining Uniform Stage of Water in Tank, Reservoir or Standpipes. Doing away with the annoyance of Freezing and Float Fixtures inside or outside of Tanks.

"Three Ways of Closing These Valves:"

1st—Automatically, by water
2nd—By Electricity, if desired
3rd—By Hand

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

No valves or fixtures inside or outside.

Sizes to 30 in.

Remember!
"HOSTS OF REFERENCES"
Valves cushioned at all times by air and water
No water hammer or bursting mains

"Made with stop starter attachment for centrifugal pumps"

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Automatic Cushioned Water Regulating Valves

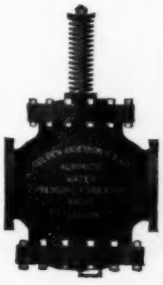
for high or low pressure service are a *necessity* for modern water works and railroads.

Positive in action and perfectly cushioned both in opening and closing.

Will maintain a constant pressure regardless of the volume of the initial flow.

When fitted with electrical attachment valve can be instantly opened to full area from any number of distant points, thus insuring full pressure in case of fire, etc.

Sizes to 30 in.



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They carry a constant water level in feed water heaters by perfectly controlling the flow of makeup water.

Operated by protected enclosed copper float.

Cushioned by both air and water.

Operate without hammering, sticking or chattering. No metal to metal seats. Made angle or straightway.

Sizes 1 in. to 30 in.

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1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air.

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Patent Automatic Double Cushioned Check Valve

Automatically prevents reverse flow of pressure.

Perfectly cushioned to prevent shock or hammer.

Especially adapted for water works to prevent disastrous reverse flow of pressure due to pumps stopping.

Arranged so that quick or slow operating may be obtained.

Sizes to 30 in.
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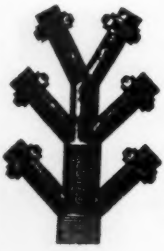
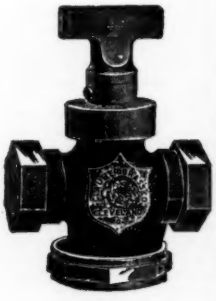
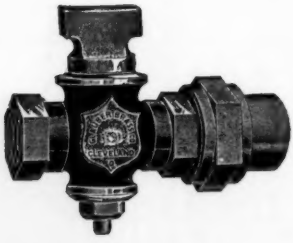
"GLAUBER" BRASS GOODS

NEVER FAIL TO MAKE A GOOD IMPRESSION - ONE THAT LASTS







GLAUBER BRASS MFG. CO.

Cleveland, Ohio

The A. P. Smith Manufacturing Company

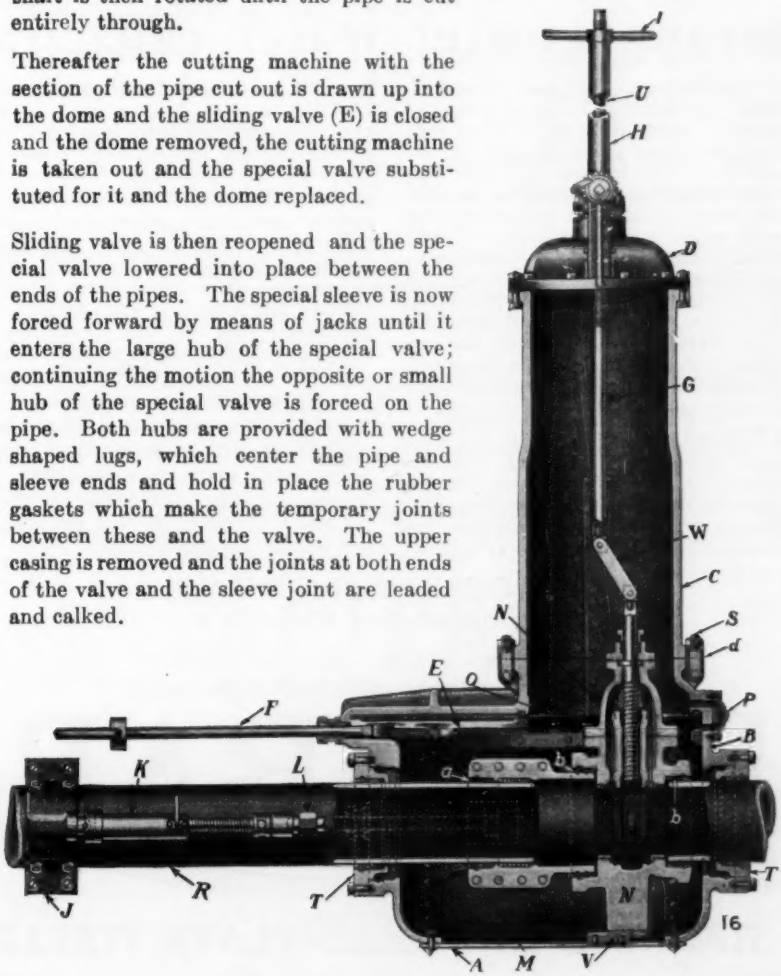
East Orange, New Jersey

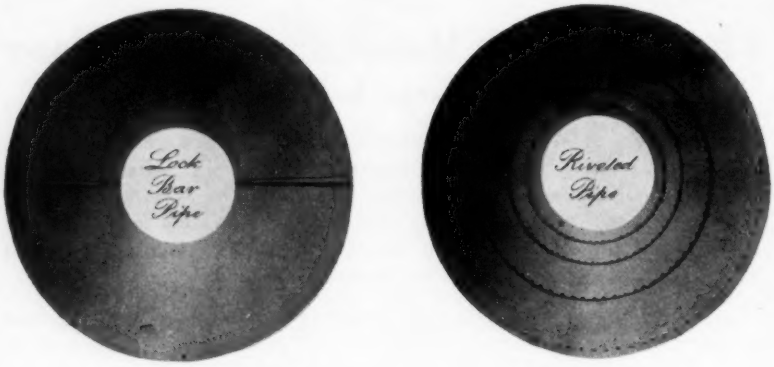
Manufacturers of Water Works Specialties, one of these specialties shown herewith, namely a Machine for inserting 4″, 6″ and 8″ valves in existing straight lines of pipe under pressure. The machine is made in other sizes as follows: No. 2 for inserting 8″, 10″ and 12″ valves, No. 3 for inserting 14″, 16″, 18″ and 20″ valves, No. 4 for inserting 24″ horizontal valves and we are now designing a machine for inserting 30″ valves.

The pipe is cut about one-half through and the special sleeve is then bolted around the pipe, the end of the sleeve being placed within a fraction of an inch of the cutting tool; the Inserting Machine is then attached around the pipe and the sleeve completely enclosing the cutting mechanism. The shaft is then rotated until the pipe is cut entirely through.

Thereafter the cutting machine with the section of the pipe cut out is drawn up into the dome and the sliding valve (E) is closed and the dome removed, the cutting machine is taken out and the special valve substituted for it and the dome replaced.

Sliding valve is then reopened and the special valve lowered into place between the ends of the pipes. The special sleeve is now forced forward by means of jacks until it enters the large hub of the special valve; continuing the motion the opposite or small hub of the special valve is forced on the pipe. Both hubs are provided with wedge shaped lugs, which center the pipe and sleeve ends and hold in place the rubber gaskets which make the temporary joints between these and the valve. The upper casing is removed and the joints at both ends of the valve and the sleeve joint are leaded and calked.





A clear water-way means greater water capacity

LOCK-BAR steel pipe has a smooth interior unobstructed by rivets and has a slightly better carrying capacity than cast-iron pipe. Riveted pipe is less smooth in the interior, the projecting rivets increasing the friction of the flowing water, and also the numerous joints with either in-and-out joints or with taper joints. For these reasons riveted steel pipe carries from 10 to 15 per cent less water than LOCK-BAR pipe or cast-iron pipe. In comparing riveted pipe with LOCK-BAR pipe and cast-iron pipe, a riveted pipe should be taken with a sufficiently greater diameter in order to carry as much water as the others.

LOCK-BAR STEEL PIPE has been held by eminent engineers, including among others, J. Waldo Smith, Clemens Herschel and Allen Hazen, to have ten to twenty per cent less resistance than riveted steel pipe.

It will be readily understood why LOCK-BAR pipe has so much more carrying capacity. Obstructions to flow, causing friction and reducing capacity are practically eliminated. The absence of obstruction and smooth inner surface further eliminates opportunity for the building up within the pipe of deposits to restrict the pipe area.

Riveted pipe is open, to some extent, to objections, due to the obstructions caused by rivet heads, but LOCK-BAR pipe has but one-fourth the number of circular seams that riveted pipe has and but 40% of the joints of a cast-iron pipe of 12-foot length. Moreover, the smooth longitudinal seams have no rivets to furnish easy attachment for foreign matter and to create eddies and the resultant friction and loss of head.

EAST JERSEY PIPE COMPANY
7 Dey Street, New York, N. Y.

WESTERN STEEL PIPE COMPANY
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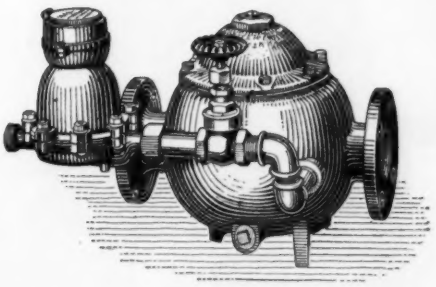

Increased yearly income $20,471.32

As a result of installing Union Compounding Valves, Toledo, Ohio, has proven once more the increased revenue of this valve.

The first installation was on twenty three meters of various types, there being thirteen 3-inch, eight 4-inch and two 6-inch. The monthly average billings before compounding increased after compounding 106 per cent, or $20,471.32 based on one year. In every instance there was an increase, the highest being 608 per cent.

Union Compounding Valves stop the leaks in revenue by measuring the small flow. For comparatively small initial investment you can secure returns in increased revenue that will astonish you. Write for catalog.

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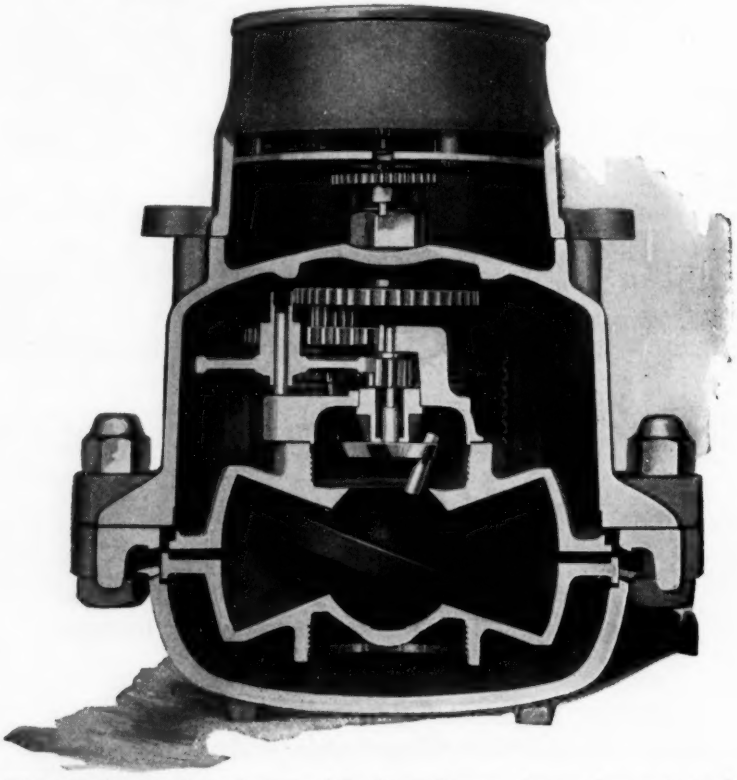
AMERICAN AND NIAGARA
WATER METERS
WITH BREAKABLE FROST BOTTOMS (Patd.)



This sectional view shows a $\frac{5}{8}$ inch or house size meter cut at right angles to the pipe line. The breakable frost bottom has been broken by a freeze up.

NOTE:

1. How the breakable section of the bottom is entirely inside and independent of the meter flange. This allows the six flange bolts to be drawn directly up on the gasket. Meter is tight on highest pressures.
2. How the breaking of the frost bottom immediately releases the measuring chamber. No warping.
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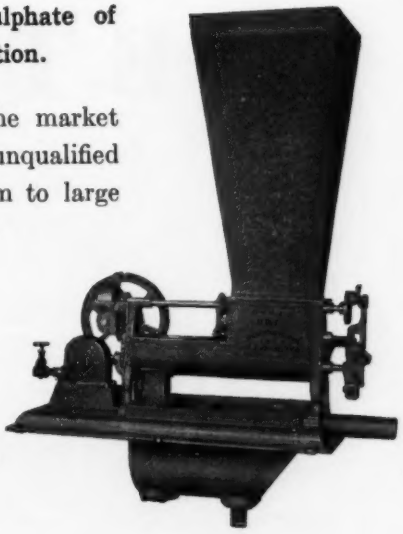

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BOTH TUBE AND REGISTER ARE STILL IN SERVICE.

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FACTORY OF THE NATIONAL METER CO.

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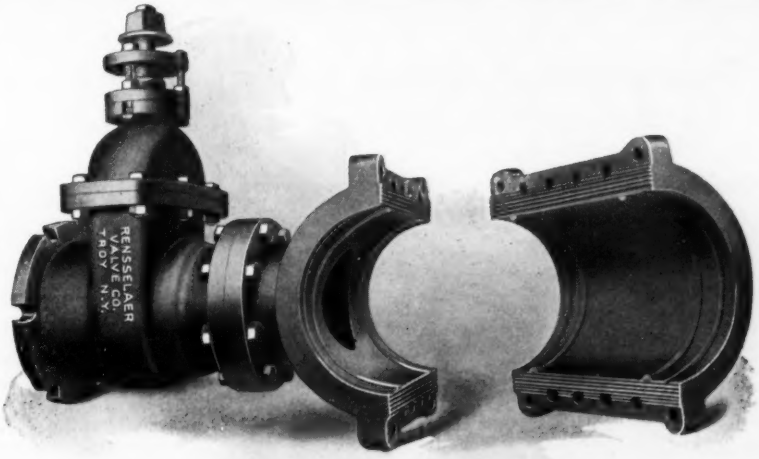

SOME of the POINTS OF SUPERIORITY of RENSSELAER TAPPING SLEEVES

Require ***less lead*** *for Calking*
Easier to center *on pipe* ***before pouring***
Give ***Extra Pipe Protection***
Bolts require ***No Iron Washers***
Each Size *carefully* ***designed for its Working Pressure***
Can be used with all Standard Tapping Machines

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Transactions of the International Conference on Sanitary Engineering, London, 1924

Distributed in the United States by the A. P. H. A.

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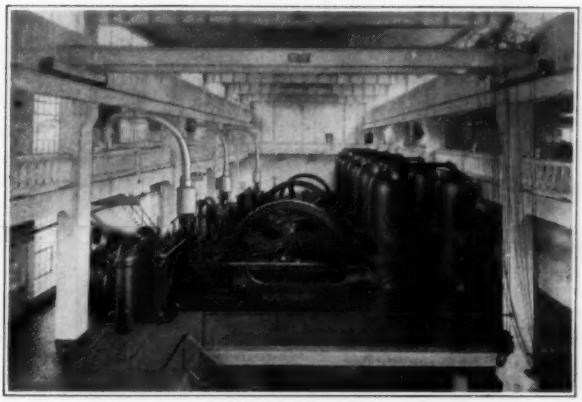

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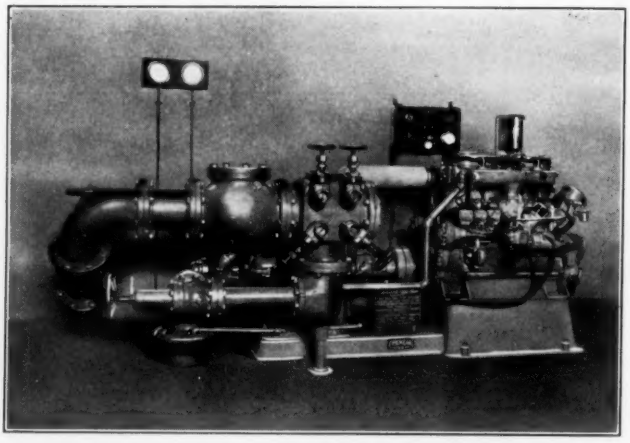

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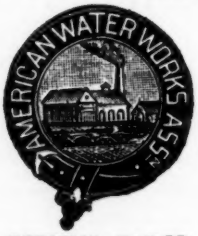

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TEMPERATURE IS MODERATED AND EQUALIZED INSIDE BOX
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DEMONSTRATED by thirty years of use in thousands of cities.

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9. UNIFORM INSTALLATION for all sizes and makes whether placed in the sidewalk, boulevard or street.

10. PERFECT LOCK—designed for this severe service. One piece bronze constructed. Nothing to corrode or require oil.

11. THE CLARK METER BOX is the ORIGINAL Northern Meter Box.

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We offer below Culture Dishes of two glasses, one satisfactory for the ordinary routine of hot air sterilization and the other for *both* hot air and steam pressure sterilization.

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Size, mm	100 x 10	100 x 15
Per pair	.60	.60
Code Word	*Emoit*	*Emojr*

FOR HOT AIR STERILIZATION ONLY

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10% discount in carton containing 1 dozen
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25% discount in lots of 10 gross

4334. **Petri Dish Covers, of Porous White Porcelain,** unglazed throughout. The smaller size fits the bottoms and the larger size fits the tops of above Petri Dishes.

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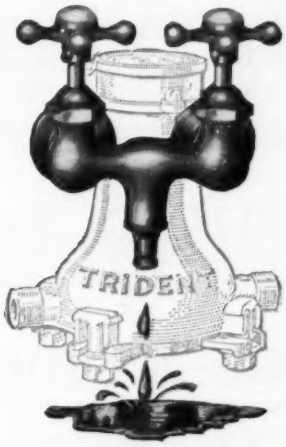

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CEMENT-LINED cast iron pipe has been put on the market by the American Cast Iron Pipe Company, as a strong, smoothly lined water pipe that will give maximum rate of flow and will resist tuberculation.

Hydraulic engineers have long felt a need for metal pipe, the interior surface of which under the worst conditions would remain smooth with age. In Acipco cement-lined cast-iron pipe, this need is supplied, the coefficient of friction being very low, thereby making it possible to deliver maximum volumes of water through distribution systems after many years of service.

Acipco cement-lined cast iron pipe are furnished in diameters from 2″ to 24″. The lining is applied by a centrifugal motion and is approximately $\frac{1}{16}$″ thick. Cement-lined pipe is suitable for many kinds of service.

Acipco cement-lined cast-iron pipe is fully described in our illustrated catalogue No. 40, a copy of which will be sent on request.

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM, ALA.

BRANCH OFFICES IN PRINCIPAL CITIES

IMPORTANT

THE Association has run short of certain numbers of the Journal. Any members who are not interested in preserving their back numbers for January and March, 1920 and 1922, and January, March, May and July, 1924, and are willing to return same, will be acting to the benefit of the Association.

AMERICAN WATER WORKS ASSN.,
170 Broadway,
New York City.

Oily condensate before and after passing through a Permutit Oil Removing Filter. Note crystal clearness of the filtered water.
(From an unretouched photograph)

Crystal Clear Water from Permutit Oil Removing Filters

Permutit Oil Removing Filters are guaranteed to remove all oil from water whether it is in suspension or emulsion. Oily condensate is transformed to water as clear as crystal and perfect for boiler feed at a cost of less than 2 cents per 1,000 gallons. Furthermore, it is not necessary to renew the filtering material from time to time as in all other types of oil filters.

Permutit Oil Removing Filters consist of a steel pressure filter filled with specially selected material. Under ordinary operating conditions the filters are washed every 24 to 48 hours and are scoured once a month, by means of the operating valves located on the apparatus.

All operations are controlled by the valves on the front of the filter and can be done by one man unaided in less than an hour. No loss of filtering material takes place, and many of these filters have been in operation for years without replacement.

It will pay you to look into this subject further. Write for our valuable booklet, "Saving Fuel and Repairs with Oil Free Feed Water." No obligations—do it today.

Permutit
Oil Removing Filters

THE PERMUTIT COMPANY,
440 Fourth Ave., N. Y.
Please send me your free book, "Saving Fuel and Repairs with Oil Free Feed Water."

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PITTSBURGH METER CO.

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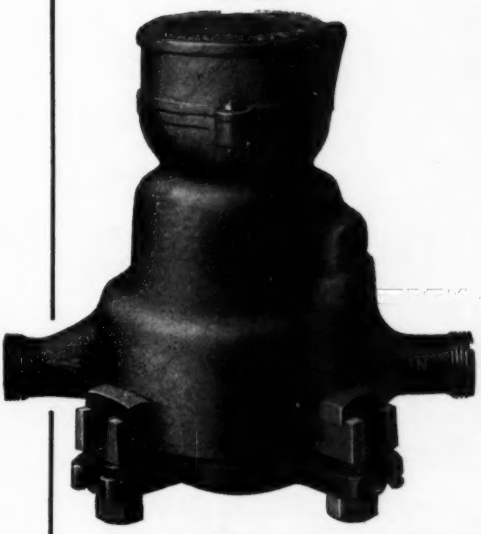
For Every Kind of Service

ARCTIC



The **ARCTIC**—a domestic service meter of the disc type, equipped with a cast iron bottom plate. This meter is especially designed for cold sections of the country but is adapted to warm sections as well.

TROPIC

The **TROPIC**—An all bronze domestic service meter of the disc type, with the connection spuds attached to the lower case. This meter is especially designed for warm sections of the country.

These two meters are identically the same excepting for the slight changes necessary to equip the ARCTIC with the frost breaking bottom plate.

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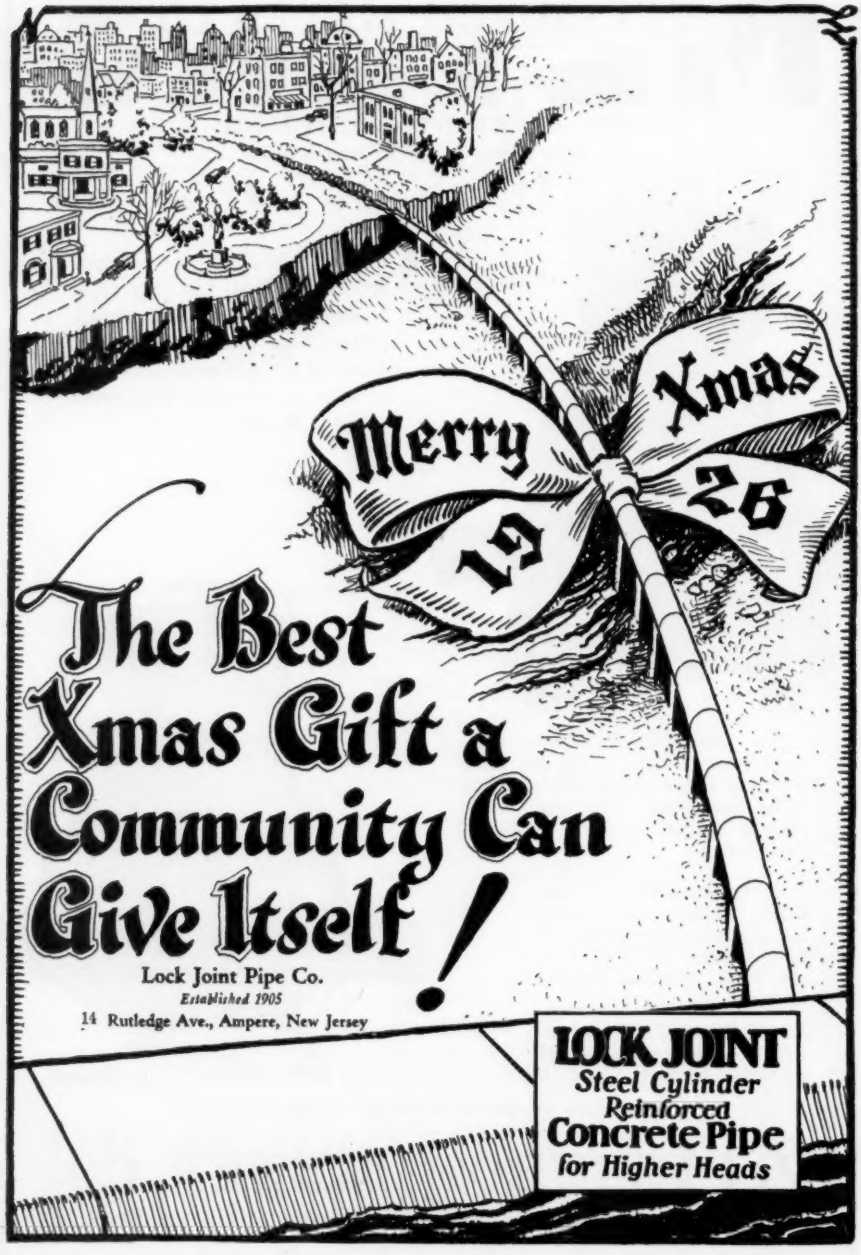
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Concrete Pipe
for Higher Heads

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Tinning protects the meter against corrosion. It adds years of life to meter service. It prevents premature decay. When accumulations occur they are much more easily removed from a tinned surface than from an untinned surface. Repairs are much less frequent and the work is much more easily accomplished.

Dipping adds a much thicker coat of metal than any other process. Therefore Hersey Meters are dip tinned. It is slow and expensive, but it gives the best results. Dip tinning is an exclusive Hersey process.

The BALANCED DISC PISTON which enables Hersey Meters to run for years without loss of registration is another exclusive HERSEY feature found in no other meter.

If performance determines your purchase of water meters, then you will want these accurate, dependable revenue computors to work for you.

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Main Office and Works: Corner E and 2nd Sts., South Boston, Mass.

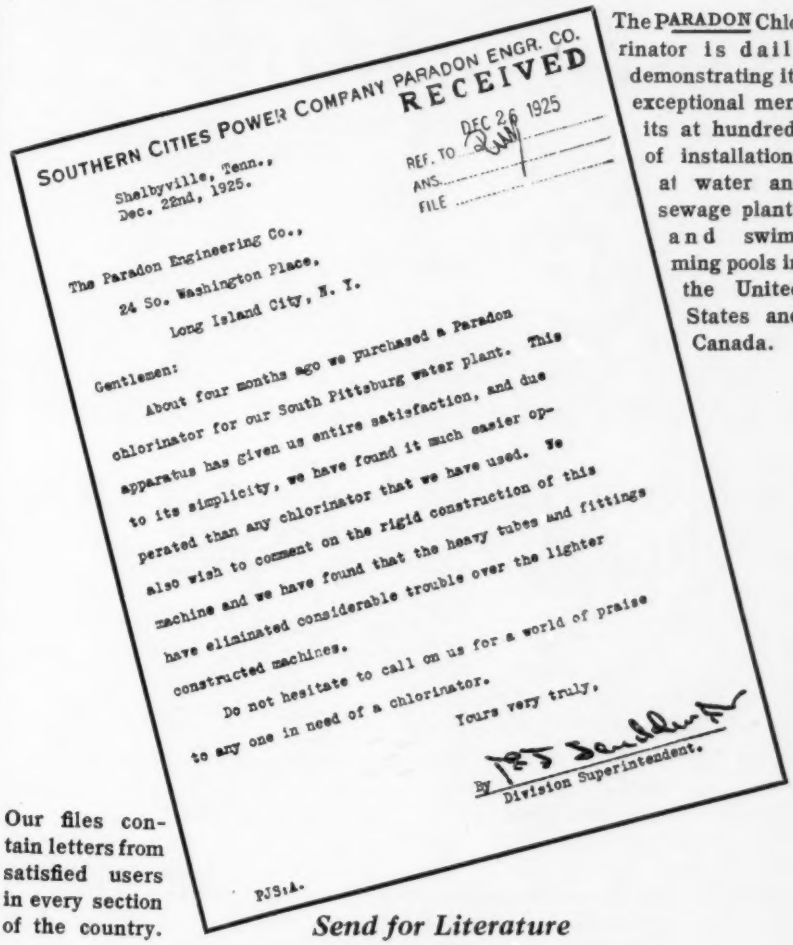
NEW YORK OFFICE

DON'T FORGET

that the Association has headquarters in New York City, where we are ready to be of service to members when possible. When in the City call at the office and make it your headquarters. Have your mail directed there if you have not made hotel reservations, and then come to the office for it, or advise where you wish it sent. Jot the address and telephone number down in your note book NOW, so as to have it when needed.

AMERICAN WATER WORKS ASSOCIATION
170 Broadway **Telephone Cortlandt 7718**

from a PARADON User



SOUTHERN CITIES POWER COMPANY

Shelbyville, Tenn.,
Dec. 22nd, 1925.

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About four months ago we purchased a Paradon chlorinator for our South Pittsburg water plant. This apparatus has given us entire satisfaction, and due to its simplicity, we have found it much easier operated than any chlorinator that we have used. We also wish to comment on the rigid construction of this machine and we have found that the heavy tubes and fittings have eliminated considerable trouble over the lighter constructed machines.

Do not hesitate to call on us for a world of praise to any one in need of a chlorinator.

Yours very truly,

By [illegible]
Division Superintendent.

PJS:A.

The PARADON Chlorinator is daily demonstrating its exceptional merits at hundreds of installations at water and sewage plants and swimming pools in the United States and Canada.

Our files contain letters from satisfied users in every section of the country.

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PARADON ENGINEERING COMPANY

Specialists in Chlorinating Apparatus for Water, Sewage and Swimming Pools

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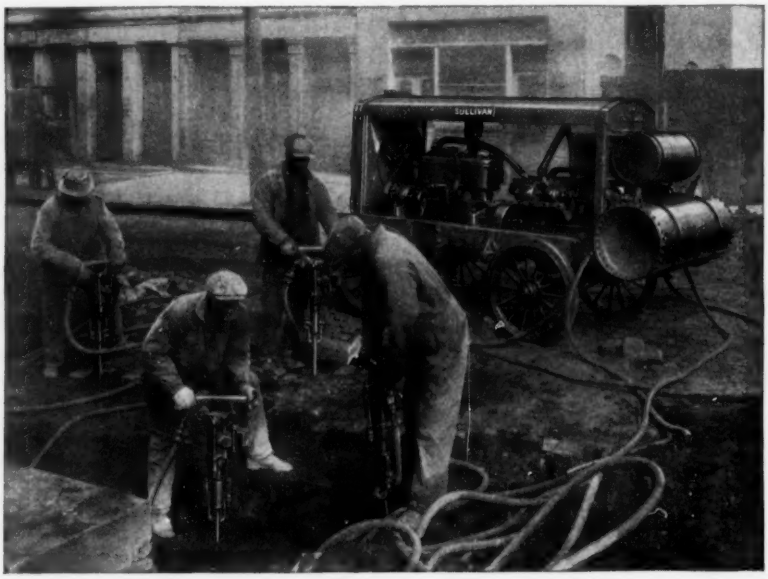
NOTE: PARADON supplies both dry feed and injector feed types of chlorinators. The injector type is licensed under the Wm. B. Bull Process, and Apparatus Patents.



Sullivan 220-Ft. Compressor Runs 4 Heavy Busters

Philadelphia had a hurry-up concrete busting job to do. The contractors put on four of their heavy concrete breakers and ran them 24 hours a day with a Sullivan 220-foot portable compressor.

All four tools smashed away steadily at the street pavement, under 80 lbs. pressure. Then came the concrete foundations of the elevated railroad (you know how hard that stuff is). Here the compressor kept three tools going.

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are built in capacities of 110 to 320-cu. ft., driven by Buda gasoline engine or by electric motor; mounted on steel wheels, rubber-tired trailers, skids, or ready for mounting on truck. Sullivan "Busters" are made in light and heavy models (48 and 75 lbs.).

A Sullivan compressor and a couple of "Busters" will cut down your cost of removing concrete when you have pipes to repair.

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Concrete Breakers	Bulletin 4381-I

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(Incorporated 1870)

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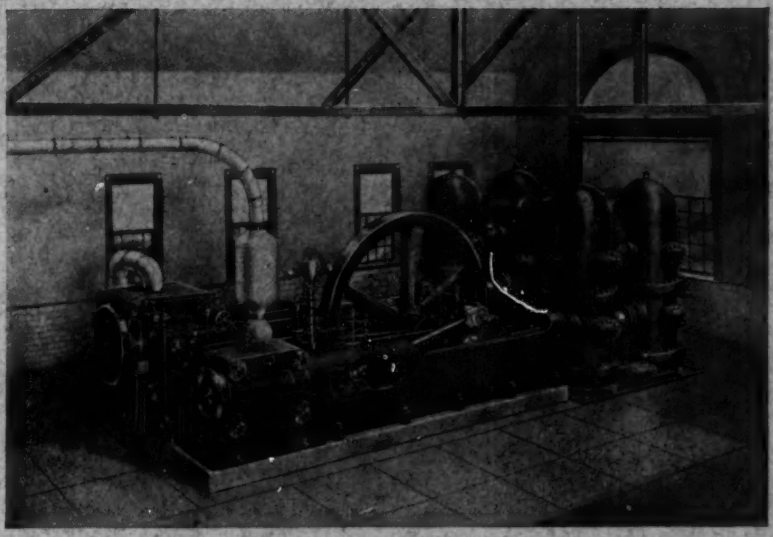

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3—Comparative Quantities. One pound of Leadite is equivalent to four pounds of lead because Leadite is so much lighter than lead.

4—Labor Saving. Saves caulking charges and digging of large bell-holes and reduces the cost of trench pumping to the minimum, facilitating rapid completion of the work.

5—Cost. Its use saves at least 50% to 75% over lead, owing to the saving effected in material and labor.

6—Tools. As no caulking is required, fewer tools are needed.

7—Transportation. Considerable freight charges are saved because Leadite is lighter than lead, and therefore you move only one-fourth the weight of jointing material.

8—Electrolysis. Leadite resists electrolysis. However, electrical thawing apparatus may be used for thawing out frozen mains or services.

9—Fuel. Saves fuel because you melt only one pound of material instead of four and not as much heat is required to melt Leadite as is needed to melt lead. Leadite will not explode or splutter when poured into wet or damp joints.

10—Delivery. We can make prompt shipments.

11—Damage Suits. Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.

12—Users. Progressive water works all over the country use Leadite and thousands of miles of pipe jointed with Leadite are in service.

Leadite is the pioneer self-caulking substitute for pig lead.

Be sure it is Leadite, and accept no imitations.

THE LEADITE COMPANY, Inc.

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WITH VOLUME TITLE, CONTENTS AND INDEX TO VOLUME 15

47TH ANNUAL CONVENTION, CHICAGO, ILLINOIS, JUNE 6-11, 1927

VOL. 16, NO. 6 DECEMBER, 1926

PROCEEDINGS 46TH YEAR

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